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A Generic Classification of the Subfamily Arctiinae of the Palaearctic and Oriental Regions based on the Male and Female Genitalia (Lepidoptera, Arctiidae)* Part I

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Abstract The Palaearctic and Oriental genera of the subfamily Arctiinae are revised and the generic diagnoses based on the male and female genitalia are given. The generic grouping is discussed and six genus groups, i.e., *Ameria*, *Utetheisa*, *Callimorpha*, *Arctia*, *Rhyarioides* and *Spilarctia* groups are proposed. In this part one new genus, *Aglaomorpha*, of the *Callimorpha* genus group is erected.

1. Introduction

The subfamily Arctiinae is one of three subfamilies of the Arctiidae, and contains many beautiful species. The larvae of some species of this subfamily such as *Hyphantria cunea* are known to be important agricultural pests. This subfamily is represented by more than 2000 species belonging to some 170 genera, and is widely distributed in all the zoological regions (STRAND, 1919). Most species of this subfamily were described in early part of the 20th century. On the other hand many attempts have been made to establish the higher classification and to clarify the relationships among genera, but no sound classification of this subfamily based on the phylogenetic relationships has been presented.

In 1901, HAMPSON published vol. 3 of Catalogue of Lepidoptera Phalaena in the British Museum in which he showed a generic classification of the Arctiinae in the world. His generic classification was mainly based on the morphology of wing venation, maxillary palpus, antenna and structure of legs, but he did not use the structure of external genitalia. His system seems to be excellent and it has been adopted by most of the later lepidopterologists, but it contains some difficulties which have not been followed by the later authors. The extent of the genus *Diacrisia* is one of such difficulties. HAMPSON treated the following genera as synonyms of the genus *Diacrisia*: *Cynis*, *Rhyparia*, *Rhyarioides*, *Spilosoma*, *Diaphora*, *Epatolmis*, *Alphaea*, *Lacydes*, *Alpenus*, *Aloa*, *Andala*, *Sanura*, *Thyrgorina*, *Binna*, *Isia*, *Spilarctia*, *Thanatarctia*, *Challa*, *Gonerda*, *Hyarias* and *Elpis*. Consequently this genus includes not only

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many but extremely varied species. On the contrary, SEITZ (1910) regarded that these 21 genera were distinct from the genus *Diacrisia*. His treatment is based on the wing markings, the size of moth and coloration of body in addition to the wing venation and the structure of labial palpus. But it is still insufficient to define the genus only on the above mentioned characters. Moreover he divided the subfamily Arctiinae sensu HAMPSON (1901) into three subfamilies, i.e., Micrarctiinae, Arctiinae and Spilosominae. In Japan the SEITZ's system has been adopted by some authors (INOUE, 1961, etc.). Recently INOUE *et al.* (1982) published the monograph of Japanese moths, in which they treated the genus *Spilarctia* as a synonym of the genus *Spilosoma*.

The differences of the limits of the Arctine genera by the authors result partly from the evaluation of the examined characters mentioned above. But the differences result fundamentally from the neglect of the morphological study on the male and female genitalia which are widely used as important characters in the systematics of Lepidoptera. Comparing the detailed structures of the genitalia, we can expect to establish soundly the border of the higher taxa and also to clarify the heterogeneous genera which were hitherto delimited by only the external characters. The study of the genitalia is indispensable to reconstruct the phylogenetic relationships among genera.

In the present paper I treated 101 described species from the Palaearctic and Oriental Regions. I have examined the morphological structure of the male and female genitalia of these species. I assigned these species to 39 genera and erected six genus groups for them. Then I considered the phylogenetic relationships among the genus groups and inter relationships among these genera. The synonymic lists of species, interspecific relationships in each genus and description of species and subspecies are excluded.

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3. General Morphology and Terminology

Some 500 dried specimens representing 101 species were used for this study. In addition, a few specimens fixed in 70% ethanol were used for the study of musculature of male genitalia. The male genitalia were cleared in boiling 5% KOH solution for 5–10 minutes, and the female genitalia in hot (60°C) 2–5% KOH solution for 6–10 hours. MAYR's hematoxyline was used to stain membranous parts. Dissection was performed under a binocular stereoscopic microscope.

3.1 Male external genital structure

For the male genitalia I mainly followed the terminology used by SHIRÔZU & YAMAMOTO (1956) and SHIRÔZU (1960).

The 8th abdominal segment has its tergum and sternum of normal condition in most genera, but in *Spilarctia* a pair of very large lamellate processes are developed on the membranous area between the 8th abdominal tergum and sternum. These processes are valva-like in general appearance, sclerotized on outer surface, membranous on inner surface, and distinctly separated from reduced 8th sternum by narrow membranous area. The function of these processes are unknown.

In some groups of this subfamily the 8th abdominal segment and the 7th–8th intersegmental region are provided with coremata, which are served for the courtship behavior. Three kinds of coremata are found in this subfamily; a group of several

modified scales on flat membrane, a tuft of moderately long hair-like scales on a membranous pouch, and long hairs regularly encircling a long retractile membranous lobe which is called "air-filled lobe" by BETHUNE-BAKER, 1925. The shape and arrangement of coremata in this subfamily may be represented by the following four types :

(1) A pair of simple retractile lobes situated on the anterosubventral portions of the 8th abdominal segment in *Amsacta*, *Areas*, *Alphaea*, *Argyartia* gen. nov., *Eospilarctia* gen. nov., *Cladartia* gen. nov. and *Paraspilarctia* gen. nov.

(2) A pair of the branched retractile lobes situated on the anterosubventral portions of the 8th abdominal segment in *Cretonotos* and *Chionartia* gen. nov.

(3) A pair of groups of modified scales are situated on the anterior portions of the lateral membranous areas and a pair of branched retractile lobes on the anteroventral portion of the 8th abdominal segment in *Spilosoma*.

(4) A pair of pouched coremata situated on the anterior portions of the lateral membranous areas and a pair of simple retractile lobes situated on the anteroventral portions of the 8th abdominal segment in *Spilarctia*.

The tegumen (9th tergum) is a large sclerite fused posteriorly with the uncus. The tegumen is usually subdivided into strongly sclerotized anterior part and weakly sclerotized posterior part. When the M.1 is constricted, posterior part of the tegumen is compressed by the uncus and anterior part of the tegumen. But in the *Spilarctia* genus group, anterior and posterior parts of tegumen are continuous with each other leaving a weak tranverse ridge between them. The anterior part of the tegumen extends ventrally to the vinculum and this portion is called the pedunculus. The pedunculus is united with the vinculum, but there is a slender membranous slit invading from the anterior margin of the ring between the tegumen and vinculum. The ventral extremity of the anterior part of the tegumen is produced into large appendix angularis in *Areas*, which articulates with the costa of the valva. In *Alphaea* posterosubventral portion of the tegumen is weakly or strongly produced posteriorly and has serration on its margin in *Alphaea imbuta*. In *Nannoartia* gen. nov. the anterior portion of ventral 2/5 is projected posteroventrally bearing several short hairs.

The anterior portion of the anterior part of the tegumen is more or less expanded and flexed, and this portion is called the 9th acrotergite. The 9th acrotergite is well developed and fold on the base of the tegumen to form a covering in some genera of the *Spilarctia* genus group.

In dorsal view the tegumen is rather broad anteriorly and narrowed posteriorly. The anteromedian portion of the tegumen is incised in various degrees, so that the shape of anterior margin of the tegumen is V-shaped, U-shaped or rectangular-shaped.

From the tegumen two muscles run to the uncus (M.1) and the diaphragma (M.2), but the adductor of the valva (M.3) widely observed in Lithosiinae and Noctuidae is absent in the Arctiinae.

M.1 (adductor of uncus) is strong, flattened isosceles triangular in shape, and originates from the anterior edge of the tegumen, and is inserted on the base of uncus.

M.2 (retractor of anus) is long and slender, originates from the anterodorsal edge

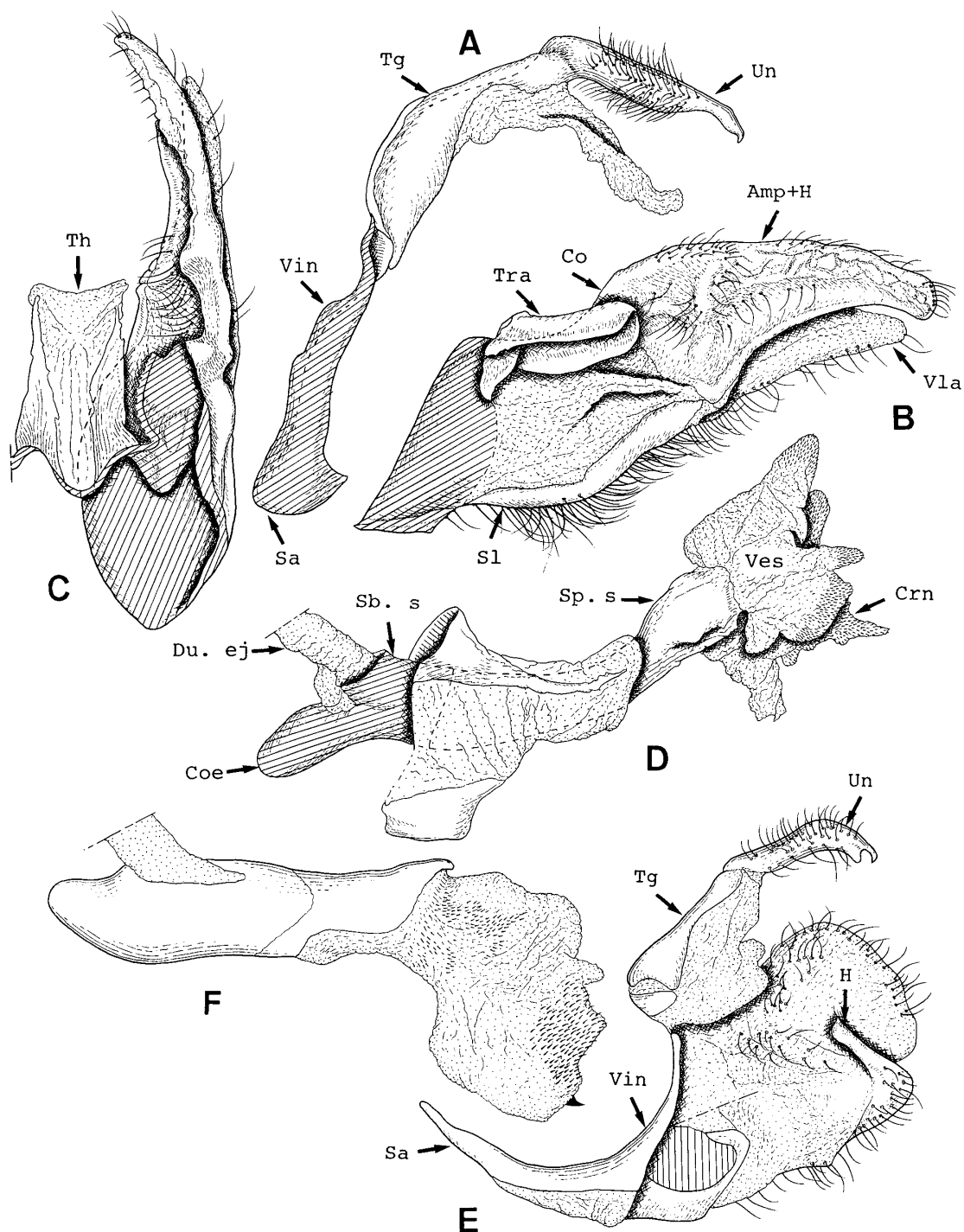


Fig. 1. Male genitalia of the Arctiinae and Lithosiinae. A-D. Male genitalia of *Callimorpha albipuncta* (Arctiinae), E-F. Male genitalia of *Conilepia nigricosta* (Lithosiinae). A. Ring in lateral view; B. Right valva in inner view; C. Left valva and theca in dorsal view; D. Phallus and juxta in lateral view; E. Ring, right valva and juxta in lateral view; F. Phallus in lateral view. Tg: tegumen, Un: uncus, Vin: vinculum, Sa: saccus, Co: costa, Tra: transtilla, Amp: ampulla, H: harpe, Amp+H: ampulla+harpe, Sl: sacculus, Vla: valvula, Th: theca, Sp. s: supr-azonal sheath, Sb. s: subzonal sheath, Coe: coecum penis, Ves: vesica, Crn: cornutus, Du. ej: ductus ejacratrius.

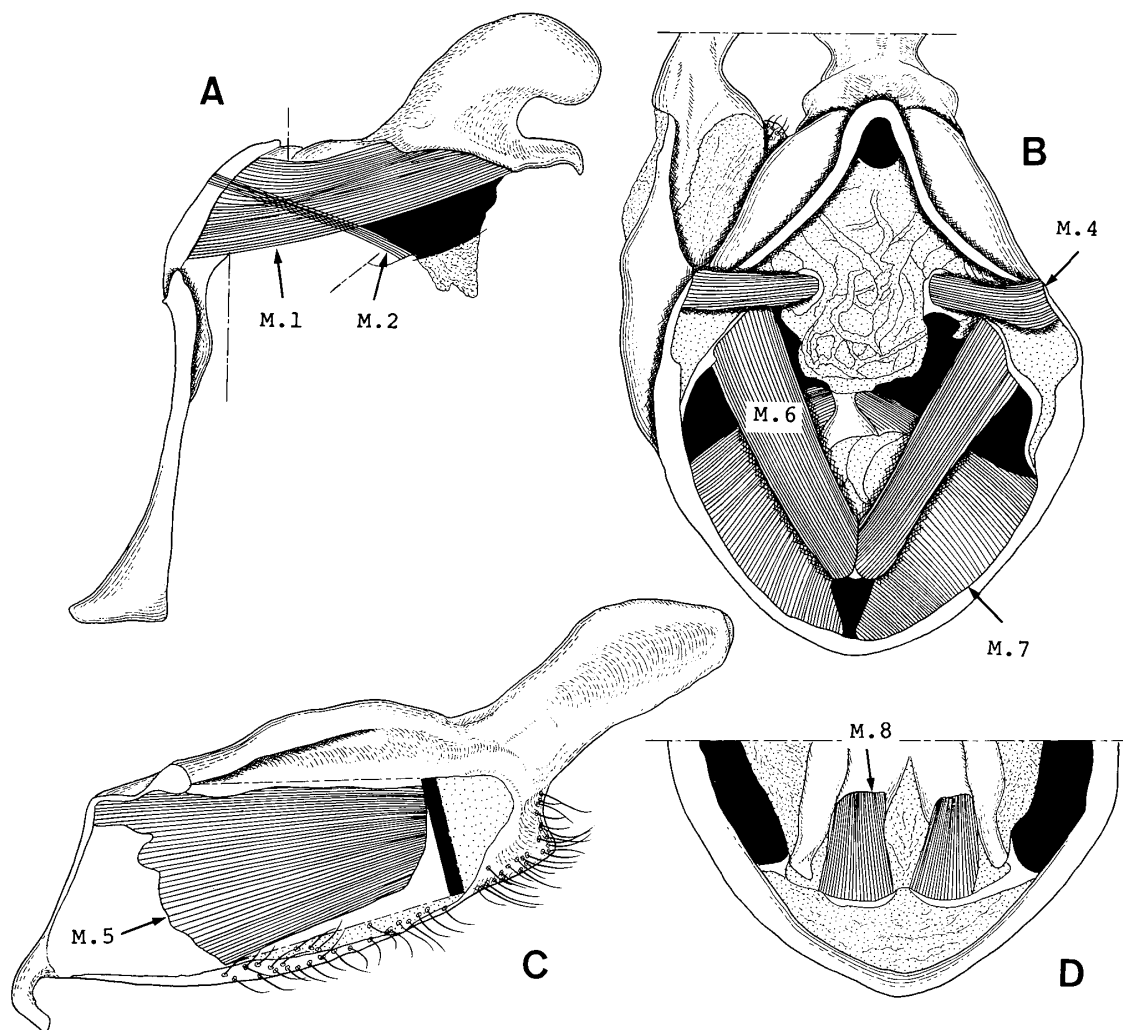


Fig. 2. Male genitalia of *Pericallia matronula* and its musculature. A. Ring in lateral view ; B. Ring in anterodorsal view ; C. Right valva in inner view ; D. Saccus and juxta in anterodorsal view.

of the tegumen, extends caudally under M.1, and is inserted on the subanal area of the diaphragma.

In dorsal view there is usually a small and rather membranous area, fenestrula, on the dorsomedian portion between the tegumen and uncus. The fenestrula is reduced in size in the *Utetheisa*, *Callimorpha*, *Arctia* and *Rhyparioides* genus groups and finally obsolete at all in the *Spilarctia* genus group. In lateral view a narrow or rather broad membranous slit from the diaphragma is observed on the base of the uncus in *Utetheisa*.

The uncus (10th tergum) is usually a simple and hook-like process, and partly separated from the posterior margin of the tegumen by slender lateral membranous areas or a dorsomedian fenestrula, or completely united with the tegumen leaving a ridge. The shape of the uncus is rather uniform, but it often bears complicated process on the basal portion as seen in *Pericallia*, *Eucharia* and *Paraspilarctia* gen. nov. The apical portion of the uncus ends in a simple acute process, but in *Areas* and *Amsacta* it is bifurcate.

The gnathos, socius, brachium and anal plate are absent in the Arctiinae.

The vinculum (9th sternum) is represented by the ventral 1/2 or less of the ring, bearing ventromedian invagination which is named the saccus. In *Phragmatobia* and *Cretonotos* the dorsal portion of the acrosternite of vinculum is very wide and expanded posteriorly. The sublateral portions of the 9th acrosternite are strongly produced posteriorly in the genus *Epatolmis*. The flexed part of the vinculum is expanded posteriorly and developed into a weakly sclerotized plate at ventromedian portion in *Utetheisa*. The saccus is usually shorter than 1/2 height of the ring. But it is well developed and elongated in *Hyperborea*, *Chelis*, *Phragmatobia*, *Epatolmis* and some species of *Thanatarctia*.

From the vinculum only one muscle runs to the transtilla of the valva (M.4). The saccus has one muscle extending to near the zone of the phallus (M.7).

M.4 (adductor of valva) is short and broad, usually originates from the dorsal end of the vinculum, and is inserted on the transtilla of the valva.

M.7 is very broad and strong, originates from the saccus, and is inserted on lateral wall of the subzonal sheath of the phallus.

Two structural types of the valva are represented in this subfamily. In one type, the inner wall of the valva is divided into basal and apical parts as seen in the *Amerila*, *Utetheisa* and *Callimorpha* genus groups. The basal part is composed of the costa, ampulla, harpe, sacculus and anellifer. The apical part is composed of the valvula and cucullus. In this case the apical portion of outer wall of the valva is widely membranous. This condition of the valva is widely observed in the Noctuidae and Lithosiinae. In *Amerila* the outer wall of the valva has a retractile scent lobe, which is entirely covered with dense hairs. The other type is observed in the *Arctia*, *Rhyparioides* and *Spilarctia* genus groups. In this type the valvula and cucullus are reduced and fused with the outer wall of the valva, so that the valva is almost uniformly sclerotized on its outer wall. The subdivision of the inner wall of the valva is rather indistinct in this type.

The inner wall of the valva in this subfamily may be divided into several portions as follows: (1) costa, which is present on the dorsoproximal region; (2) ampulla, on the dorsodistal region; (3) harpe, on the ventrodial region, when the division of the harpe and ampulla is indistinct, the terminal region of the valva is named the harpe+ampulla; (4) sacculus, on the ventroproximal region; (5) anellifer, membranous basal region, surrounded by the costa, ampulla, harpe and sacculus; (6) transtilla, dorso-proximal projection derived from the costa. When the apical part of the valva is present, the cucullus and valvula are added to the division of the inner wall: (7) cucullus, on the dorsodistal region; and (8) valvula, on the ventrodial or distal region.

The costa is usually very narrow and long sclerotized area, separated from the ampulla or the harpe+ampulla by the membranous anellifer, or continuous to the dorsoproximal portion of the harpe+ampulla. In *Pericallia* the basal portion of the costa is produced to form a horn-like process. In *Aglaomorpha* gen. nov. the costa bears a very large and long process extending posteriorly from its apical portion. In *Cladarctia* gen. nov. the costa is very large and occupies dorsal 1/3 of the basal portion

of inner wall of the valva.

The distinct ampulla is represented only in the *Utetheisa* genus group. In this genus group ampulla produces a short hairy dorsal process from its middle portion.

The harpe is present as a small triangular sclerite independent from the ampulla on the medioventral portion of valva only in the *Utetheisa* genus group.

In four other genus groups the harpe and ampulla are completely united with each other. The shape of harpe+ampulla is variable, and the following six types can be recognized: (1) the harpe+ampulla broad, its dorsal half distinctly concaved, as seen in the *Rhyparioides* genus group; (2) the harpe+ampulla well developed, much longer than costa and distally produced into an elongate process in the *Callimorpha* genus group; (3) the harpe+ampulla much shorter than the costa, with its apical portion strongly elongated posteriorly, cylindrical or spatulate in shape in the *Arctia* genus group; (4) the harpe+ampulla slender and tapering towards tip, and its middle portion expanding inwardly or projecting into a small wedge-shaped process in *Thanatarctia* and *Phragmatobia*; (5) as inner wall of broad apical portion of valva is widely occupied by the anellifer, the harpe+ampulla reduced to a slender sclerotized band along distal margin of the valva in *Amsacta* and *Areas*; and (6) the harpe+ampulla well developed and occupying nearly apical $1/3 - 1/2$ of the valva, produced distally into very variable processes as seen in most genera of the *Spilarctia* genus group.

The anellifer is a broad membranous area. It occupies nearly $1/3 - 3/5$ of the valva or nearly ventral $1/2 - 2/3$ of the basal $1/2 - 2/3$ of the valva.

The sacculus is usually very long and narrow, sometimes indistinct and rarely developed into a large sclerotized band. In *Amsacta* and *Areas* the sacculus is very wide and well developed, and in *Eospilarctia* gen. nov., *Cladarctia* gen. nov. and *Paraspilarctia* gen. nov. its posterior portion is well expanded. Ventral portion of the sacculus is furnished with many distinct short spines in *Amsacta*.

The transtilla is usually well developed and elongated towards median line. The base of the transtilla is very wide and it serves as the attachment of M.4 as seen in *Aglaomorpha* gen. nov. The apical portion of the transtilla and a part of the diaphragma are united with each other to form a lobe-like process, which is called the labides. The labides is a characteristic structure of the *Arctia* genus group except for *Eucharia*.

In *Cretonotos* the inner wall of the valva is almost uniformly sclerotized, so that the subdivision of the inner wall becomes indistinct.

The cucullus tends to elongate and ends in an acute process or in rounded distal margin on the dorsal half of the posterior part of the valva as only seen in the *Utetheisa* genus group.

The valvula is a broad membranous or semimembranous area. It occupies nearly ventral $1/2$ of distal part of the valva in the *Utetheisa* genus group or entire surface of distal part of the valva in the *Callimorpha* genus group.

In *Utetheisa* the valva is provided with a pocket-like scent gland which is invaginated from a vertical slit of the middle portion of its outer wall. In *Nikaea* the base of outer wall of valva has a long membranous lobe which is densely clothed with many small papillae on its entire surface.

From the valva muscle each a runs to the aedeagus (M.6) and the juxta (M.8), respectively. M.5 is situated inside of the valva.

M.5 (flexor of harpe) is broad, usually originates from the ventroproximal edge of the sacculus and is inserted into the edge of the harpe or harpe+ampulla, sometimes M.5 connects either the costa or the subbasal portion of outer wall or the posterior portion of anellifer.

M.6 (protractor of phallus) is a massive muscle and connects the basal margin of valva and the dorsal portion of subzonal sheath of the phallus or the wall of anterior extremity (usually coecum penis) of the latter.

M.8 (protractor of juxta) is short and flat, usually originates from the ventral edge of the valva and is inserted into anterior portion of the juxta.

The juxta is symmetrical and variable in shape. In *Parasemia* the juxta is asymmetrical. In the *Amerila*, *Utheteisa* and *Callimorpha* genus groups the juxta is a rather small, roof-shaped, flat sclerite. But in the *Arctia*, *Rhyparioides* and *Spilarctia* genus groups it is rather large, rounded on the basal portion, parallel-sided on apical portion, and strongly emerginate on apical margin. In *Hyperborea*, *Rhyparia* and *Rhyparioides* the juxta has many minute spinules on its lateral portions of posterior $1/2 - 1/3$.

The inner layer of anellus, which surrounds the aedeagus at the zone, is called the manica. It is usually membranous, but sometimes has lateral sclerotizations which are continuous to the juxta in some species of the *Spilarctia* genus group. The postero-dorsal portion of manica is elongated posteriorly, which is called the theca. This characteristic structure is well developed in the *Callimorpha* genus group.

The phallus is usually nearly straight, but is sometimes curved dorsally in various degrees as seen in *Epicallia*, *Arctia*, *Pericallia*, *Rhyparia*, *Rhyparioides*, *Nannoarctia* gen. nov., *Micrarctia*, *Artimelia* and *Paraspilarctia* gen. nov. The subzonal sheath of aedeagus is usually $1/3 - 1/2$ as long as the entire length of the aedeagus. But in *Spilarctia* it is longer than $1/2$ of the aedeagus. The coecum penis is usually not much developed. In the *Callimorpha* and *Arctia* genus groups and some genera of *Spilarctia* genus group it is well developed. The ventral portion of subzonal sheath sometimes has a concaved area, on the edge of which the muscle M.7 is inserted. There is a membranous portion on the apex of aedeagus, which is called the perivesical area. In most genera of the Arctiinae the perivesical area is very narrow and occupies the both sides of the apex of aedeagus. The dorsal perivesical area extends to near the zone in *Cladarctia* gen. nov., *Spilosoma* and *Chionarctia* gen. nov. There are variable spines or short processes on aedeagus which are called the carina penis. It is represented by several distinct short spine-like processes on right lateral wall of the apex of the aedeagus in some species of *Spilarctia*, *Spilosoma* and *Amsactoides*. Serrate carina penis appears on dorsal or right dorsolateral wall of subapical portion of the supra-zonal sheath in *Rhyparioides*, *Hyperborea* and *Areas*. In *Parasemia*, *Pericallia*, *Epicallia* and *Eucharia* the carina penis is represented by distinct many short or rather long spines on the left ventrolateral surface of the supra-zonal sheath. In *Chelis* and *Phragmatobia* the carina penis is represented by several or many short spines

on left lateral wall of apical portion of suprazonal sheath. In *Alphaea imbuta* the left posterolateral wall of suprazonal sheath is furnished with carina penis of a distinct stout short process. The vesica is usually well developed and $1/4 - 3/5$ as long as the aedeagus. Size of vesica and that of cervix bursae of female genitalia may be correlated to each other. The vesica has some kinds of cornuti which are composed of various spines, plate and processes; the size, number and formation of cornuti are usually species-specific. The vesica is usually everted posteriorly, but ventrally everted in some members of *Callimorpha* and *Aglaomorpha* gen. nov., dorsally everted in *Calpenia*, *Parasemia*, *Hyperborea*, *Alphaea* and *Amsacta*, anteriorly everted in *Chelis* and laterally everted in *Diacrisia*, *Rhyparia*, *Rhyparioides*, *Nannoarctia* gen. nov., *Micrarctia* and *Artimelia*.

3.2 Female external genitalia and internal reproductive organs

The structure of female external genitalia much differs among both species and genera and includes many characters very useful in the natural grouping of the Arctiinae. The structural pattern of internal reproductive organs is uniform in each genus of this subfamily, but its shape and size are different among species.

For the female genitalia and internal reproductive organs, I followed the terminology used in KLOTS (1956) and CALLAHAN (1960).

In *Utetheisa* there is a pair of large sclerotized depressions on the lateral portions of the 6th – 7th intersegmental region. This depressions are presumably clasped by the tips of cuculli of the male valvae during copulation.

In most genera of the Arctiinae the 7th abdominal tergum is well developed and large.

The 7th abdominal sternum is usually well sclerotized and large, but in *Spilarctia* it is partly membranous. In *Epicallia*, *Diacrisia*, *Thanatarctia*, *Amsacta*, *Cretonotos*, *Areas*, *Argyartia* gen. nov. and *Spilosoma* the ventral region of this segment is almost membranous, and its sternum is reduced or entirely obsolete.

There is a large tongue-shaped sclerite which may be reduced 7th sternum on the postoventral area of the 7th segment in *Areas* and *Amsacta*, but its function is unknown.

A pair of very wide depressions is present on the lateral membranous areas of the 7th abdominal segment in *Callimorpha albipuncta*. These depressions are presumably clasped by the tips of the harpe + ampulla regions of the male valvae during copulation. Other species of this genus also have similar but weaker concaved areas on posterior $1/2$ of the lateral membranous areas. In *Aglaomorpha* gen. nov. there is a pair of large transverse excavations along posterior margin of 7th abdominal sternum. The excavations are presumably clasped by the ampullae of the male valvae during copulation.

A complicated sclerite is present on the posterior portion of ventral area of the 7th abdominal segment in *Parasemia*, *Arctia* and *Epicallia*. It seems to have a function clasped by the male valvae during copulation.

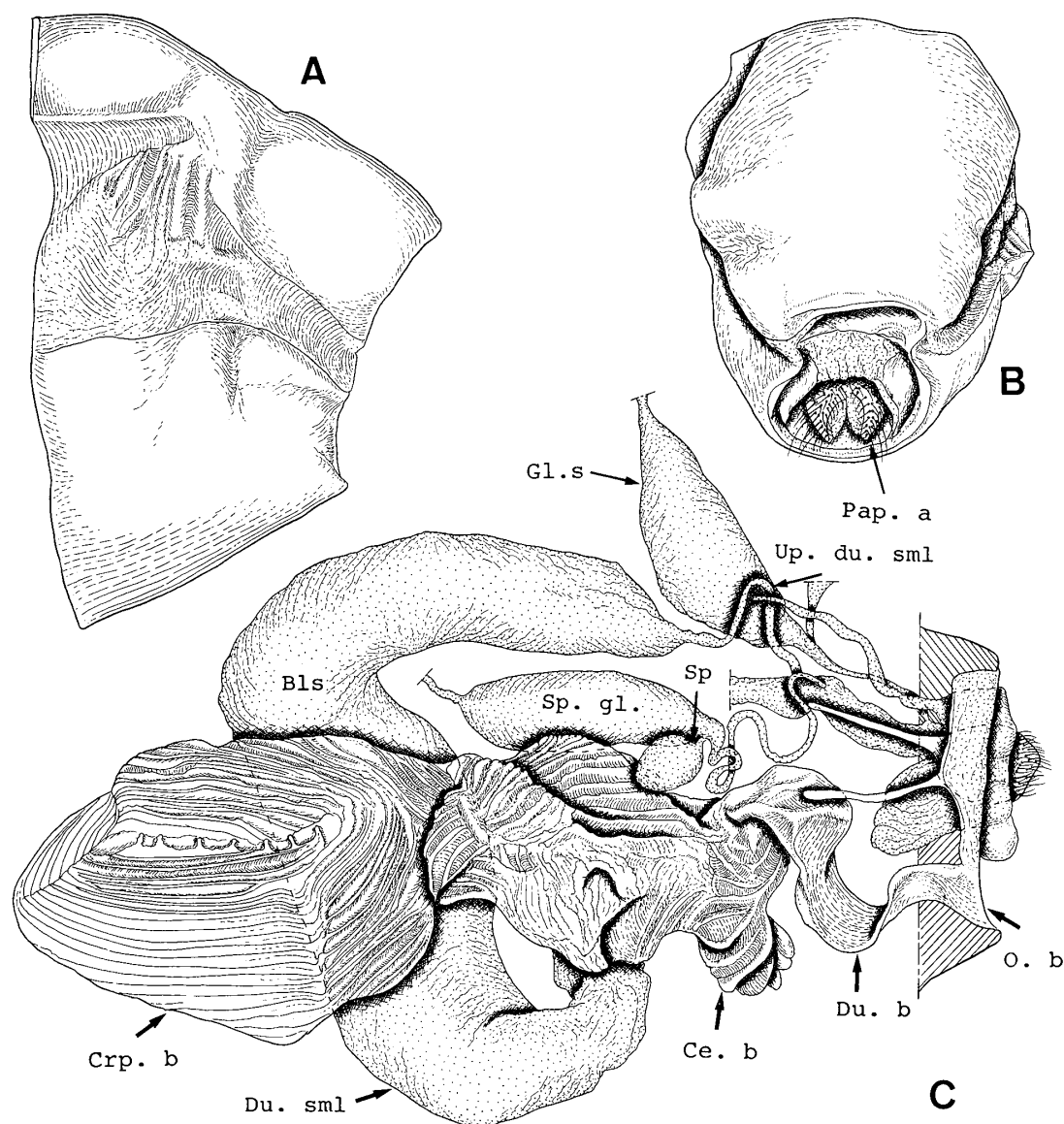


Fig. 3. Female terminalia and internal reproductive organs. A – C. *Callimorpha similis*. A. Seventh abdominal segment in lateral view ; B. External genitalia in postero-ventral view ; C. Internal reproductive organs in lateral view. Pap. a : papilla analis, O. b : ostium bursae, Du. b : ductus bursae, Ce. b : cervix bursae, Crp. b : corpus bursae, Bls : bulla seminalis, Du. sml : ductus seminalis, Up. du. sml : upper part of ductus seminalis, Gl. s : glandula sebacea, Sp : spermatheca, Sp. gl. : spermathecal gland.

In *Arctia* the 7th abdominal tergum is well sclerotized and indistinctly separated from the 7th sternum. The 7th sternum has a deep ventromedian longitudinal groove which is presumably hooked by the labides of male genitalia during copulation in *Arctia*.

In *Thanatarctia* the 7th abdominal tergum and sternum are strongly desclerotized or disappear, so the entire surface of this segment is almost membranous, and clothed

with dense soft short hairs which are used to cover the laid eggs.

The 8th abdominal segment is only partly visible. The 8th abdominal tergum is well sclerotized, but much reduced in length, and much shorter than the 7th abdominal tergum.

The 8th abdominal sternum is usually well sclerotized and separated from the tergum by a narrow to rather wide lateral membranous areas, and it is sometimes broadly emarginated posteriorly by a membranous area, and it is ventrally divided into a pair of sternites. In some genera of this subfamily the 8th tergum is fused with its sternum, so that the 8th abdominal segment is uniformly sclerotized. In the *Arctia* genus group there is a small excavation on the middle portion of the 8th abdominal sternum, and it is hooked by the uncal tip of the male genitalia during copulation. The 8th abdominal segment bears a pair of apophyses anteriores which are usually slender, short and extends anteriorly or anterodorsally. The apophysis anterioris is rudimentary in *Cretonotos* and *Eospilarctia* gen. nov. In the former genus rudimentary apophysis is situated much more ventrad than the other genera. In *Areas* the apophysis is situated on the subdorsal portion of the 8th tergum.

Between the 7th and 8th abdominal sterna there is a rather large cavity, in which the ostium bursae opens. The anterior wall of the ostium bursae is sclerotized in various degree, which is called the lamella antevaginalis. It is usually wide and concaved. In *Spilosoma* a pair of deep rounded concavities, which are clasped by the processes of harpe+ampulla regions of valvae during copulation, are developed on each side of the ostium bursae. There is a strongly sclerotized area posterior to the ostium, which is called the lamella postvaginalis. The lamella postvaginalis is often fused with the lamella antevaginalis. The lamella postvaginalis is variable in the shape or the degree of sclerotization among species. In *Grammia*, *Diacrisia* and *Rhyparioides* the lamella postvaginalis has a small sclerotized invagination which is presumably hooked by the uncal tip of the male genitalia during copulation.

The ostium bursae is deep and oval or lenticular in shape.

There is a pair of small membranous invaginations on the subdorsal portions of intersegmental membranous areas between the 8th abdominal segment and the papilla analis, and the invaginations are clasped by the tips of the harpe of the male valvae during copulation as seen in *Amerila*.

The papilla analis is usually triangular or rectangular in shape and bears many soft hairs on its entire surface. In addition to these hairs, the papilla analis is densely covered with fine short hairs on its dorsoproximal portion in *Eospilarctia* gen. nov., *Cretonotos* and *Spilarctia*. In *Eospilarctia* gen. nov. the papilla analis is very large. The membranous subanal area is weakly concaved. The area is pushed up by the protuberance of male uncus during copulation in *Pericallia*. The apophysis anterioris is usually a short process invaginated from anterolateral margin of papilla analis.

There is an invaginated genital chamber, i.e. the sinus vaginalis mid-ventrally and caudad of the 7th sternite.

The term bursa copulatrix is used for the composite structure which consists of the ductus bursae, the cervix bursae and the corpus bursae. In the Arctiinae it is rather

small in comparison with that of most noctuids, it usually extends anteriorly to posterior 1/2 of the 6th segment, but in *Utetheisa* its end reaches posterior portion of the 5th segment.

The ductus bursae may be variously sclerotized and subdivided into three regions such as the antrum, narrow membranous area and ductus bursae. The antrum is well sclerotized, short and situated on the posterior portion of ductus bursae. There is a narrow membranous area between the antrum and the ductus bursae, but in *Utetheisa*, most species of *Callimorpha*, *Aglaomorpha* gen. nov., *Parasemia*, *Cretonotos*, *Thanatarctia* and *Eospilarctia* gen. nov. it is absent so that the ductus bursae is almost uniformly sclerotized. The ductus bursae is usually well sclerotized, straight and directly led into the cervix bursae or the corpus bursae. In *Amerila* it is membranous and attached to the corpus bursae. In *Callimorpha*, *Aglaomorpha* gen. nov. and *Parasemia* it is curved or directed anterodorsally. In *Cretonotos*, *Amsacta*, *Thanatarctia*, *Eospilarctia* gen. nov., *Spilosoma*, *Chionarctia* gen. nov. and *Spilarctia* it is arched or directed anteroventrally. In *Diacrisia* and *Rhyparioides* it is attached to the middle portion of right lateral side of cervix bursae.

The posterior portion of the corpus bursae, when enlarged and sclerotized, is called the cervix bursae. The development of the cervix bursae and the size of everted vesica of the male genitalia in the Arctiinae may be correlated to each other. There are sometimes many complicated furrows or streaks on its wall. In *Grammia* it is situated on the right lateral side of corpus bursae and attached to the posterior portion of the right lateral side of corpus bursae. In *Amerila* it is undeveloped.

The corpus bursae is very large, globular or oval in shape and its sclerotization is very variable among the genera. It is situated anteriorly to the cervix bursae and usually continuous to it. But in *Rhyparioides* it is situated above the cervix bursae and has a relatively narrow duct led from the cervix bursae. The inner surface of corpus bursae often bears two to several sclerotized signa, each of which is usually represented by a circular plate, rarely by a band-like sclerite. The circular signum is often provided with spinules or strong spines.

There is a narrow duct connecting the bursa copulatrix and the vestibulum of vagina, which is called the ductus seminalis. The structural pattern of the ductus seminalis of the Arctiinae may be fundamentally represented by the following three types: (1) a slender, simple duct, (2) a strongly swollen, simple duct, the both ends of which are tapered, (3) a complicated duct, of which the middle portion is deformed as a large coecum or sac which is called the bulla seminalis. The shape and size of the ductus seminalis or the bulla seminalis are very variable. In the genus *Spilarctia* only the basal 1/2 of lower part of the ductus seminalis is well sclerotized. The point of attachment of the ductus seminalis to bursa copulatrix is different among the genera. In *Amerila* this point is situated on the subdorsal portion of posterior 1/2 of left lateral side of the corpus bursae. In *Utetheisa* it is situated on the posterior end of right ventral side of the cervix bursae. In the *Arctia* genus group it is situated on the dorsal portion of right lateral side of the cervix bursae. In the other genera it is situated on the right ventral side or right lateral side of the cervix bursae. In the type (3), the

connection between the lower part of ductus seminalis and bulla seminalis is variable. In *Rhyparioides*, *Thanatarctia*, *Argyartia* gen. nov. and *Spilarctia* the lower part of ductus seminalis is connected to the posterior portion of bulla seminalis. In *Hyphoraia*, *Epicallia*, *Arctia*, *Pericallia*, *Grammina*, *Areas*, *Cretonotos*, *Chionarctia* gen. nov. and *Spilosoma* the connection is situated on the right lateral side of bulla seminalis. The upper part of ductus seminalis is a slender tube connecting the bulla seminalis and the vestibulum of vagina, and is usually continuous to the posterior portion of bulla seminalis. But in *Utetheisa*, *Rhyparioides*, *Amsacta*, *Argyartia* gen. nov., *Spilosoma*, *Chionarctia* gen. nov. and *Spilarctia* the connection is situated at the middle portion of left lateral side or dorsal surface of the bulla seminalis.

The spermatheca (receptaculum seminis) consists of a tubular spermathecal gland, a large lobe (utriculus) and a small lobe (legena). The outer surface of utriculus is convoluted in many species. The ductus receptaculi is long, twisted twice or three times and consists of a membranous duct and a weakly sclerotized band surrounding the duct. This duct usually arises on the dorsal portion of vestibulum situated just posteriorly to the attachment of ductus seminalis, but in *Amsacta* it is situated anteriorly to the attachment of ductus seminalis.

There is a pair of thick or thin and long sacs, which are called the glandulae sebaceae on the oviductus communis. The duct of glandulae sebaceae opens posteriorly to the vagina. It is usually situated above the bursa copulatrix, but in *Argyartia* gen. nov. it is lateral to the bursa copulatrix.

There is a couple of glands which open to the lateral sides of intersegmental membranous areas between the 8th abdominal segment and papillae anales. They seem to be scent glands, and variable in size and shape among the species, but in *Amerila* these glands are absent.

4. Descriptions of Genera

4.1 Subfamily Arctiinae HAMPSON, 1901

Type genus: *Arctia* SCHRANK, 1802

Arctiinae HAMPSON, 1901, Cat. Lepid. Phalaenae Br. Mus., 3.

Arctiinae SEITZ, 1910, in SEITZ, Gross-Schmett. Erde, 2: 92.

Callimorphinae SEITZ, 1910, Ibid., 2: 100.

Micrarctiinae SEITZ, 1910, Ibid., 2: 71.

Spilosominae SEITZ, 1910, Ibid., 2: 84.

Arctiinae FORBES, 1939, Bull. Mus. comp. Zool. Harv., 85.

Arctiini FORBES, 1960, Lepid. New York & neighboring states, 4.

Callimorphini FORBES, 1960, Ibid., 4.

Utethesini FORBES, 1960, Ibid., 4.

Arctiinae INOUE, 1961, Check List Lepid. Japan, 6.

Arctiinae WATSON, 1980, The Generic Names of Moths of the world, 2. (part)

4.1.1 The *Amerila* genus group

The *Amerila* genus group is represented by a single genus, *Amerila* WALKER and characterized in genitalia as follows: Male genitalia with ring very narrow, small, weakly sclerotized; large and rounded valva with retractile scent lobe on its outer wall; a horn-like process on harpe; female genitalia with ductus bursae membranous; cervix bursae absent; ductus seminalis arising from corpus bursae; bulla seminalis absent; scent gland absent.

This genus group is sharply separated from the other genus groups of the Arctiinae by the above mentioned characters of male and female genitalia.

4.1.1.1 Genus *Amerila* WALKER, 1855

Amerila WALKER, 1855, List Specimen lepid. Insects Colln Br. Mus., 3: 725. Type species: *Sphinx astereus* DRURY, 1733, by subsequent designation by HAMPSON, 1900, *Ann. S. Arf. Mus.*, 2: 60.
Canopus WALKER, 1855, List Specimen lepid. Insects Colln Br. Mus., 3: 747. Type species: *Canopus bubo* WALKER, 1855, by subsequent designation by HAMPSON, 1900, *Ann. S. Arf. Mus.*, 2: 60.

Male external genitalia: Tegumen in lateral view very narrow and slender, extending dorsally, posterior part of tegumen weakly sclerotized and very slender, almost as high as length of uncus; pedunculus rather broad and fused with dorsal part of vinculum, with a triangular membranous area; acrotergite undeveloped. Uncus very small, with several short hairs on its anterodorsal margin. Vinculum long and slender, about 1/2 as deep as ring, without saccus. Valva large and elliptical; costa very large, occupying dorsal 1/3 of valva; anellifer broad and occupying central 1/3; harpe present on distal corner of anellifer, horn-like, curved distally at base; sacculus broad and occupying ventral 1/3; costa and sacculus densely clothed with stiff hairs; outer wall of valva almost membranous bearing retractile scent lobe, which is entirely covered with dense hairs. Juxta in ventral view rather small and elliptical. Phallus very short and thick, weakly sclerotized, nearly straight; suprazonal sheath 1/3 as long as aedeagus, without carina penis; coecum penis rather long; vesica everted posteriorly, 1.5× as long as aedeagus, with a semicircular sclerite and two stiff long spines.

Female external genitalia: Seventh abdominal tergum and sternum well developed and sclerotized. Broad lateral membranous areas present between 7th tergum and sternum. Eighth abdominal segment 1/2 as high as 7th segment; 8th tergum and sternum well sclerotized, and separated by broad lateral membranous areas, 8th sternum and copulatory cavity asymmetrical. Copulatory cavity well sclerotized, bilge-shaped in lateral view; ostium bursae circular, situated on the center of copulatory cavity; apophysis anterioris rather short and weakly curved dorsally, 1/5 as long as height of 8th segment. A small membranous invagination present on subdorsal portion of intersegmental membranous area between 8th segment and papilla analis. Papilla analis large and rectangular in lateral view, with many short hairs; apophysis posterioris nearly straight, 1.5–3× as long as apophysis anterioris.

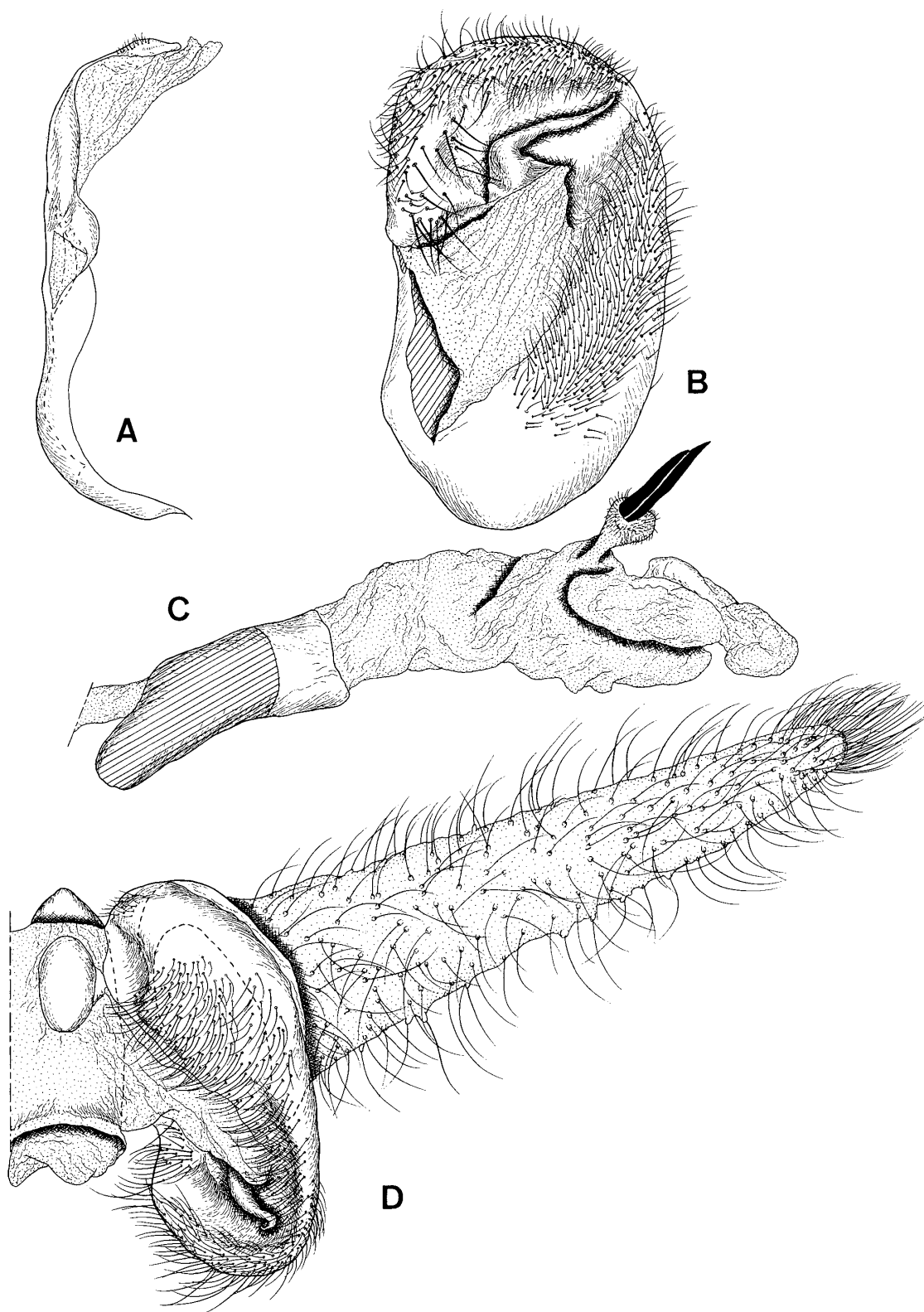


Fig. 4. Male external genitalia of *Amerila astreus* (DRURY). A. Ring in lateral view ; B. Inside of right valve ; C. Left valva and juxta in ventral view ; D. Phallus in lateral view.

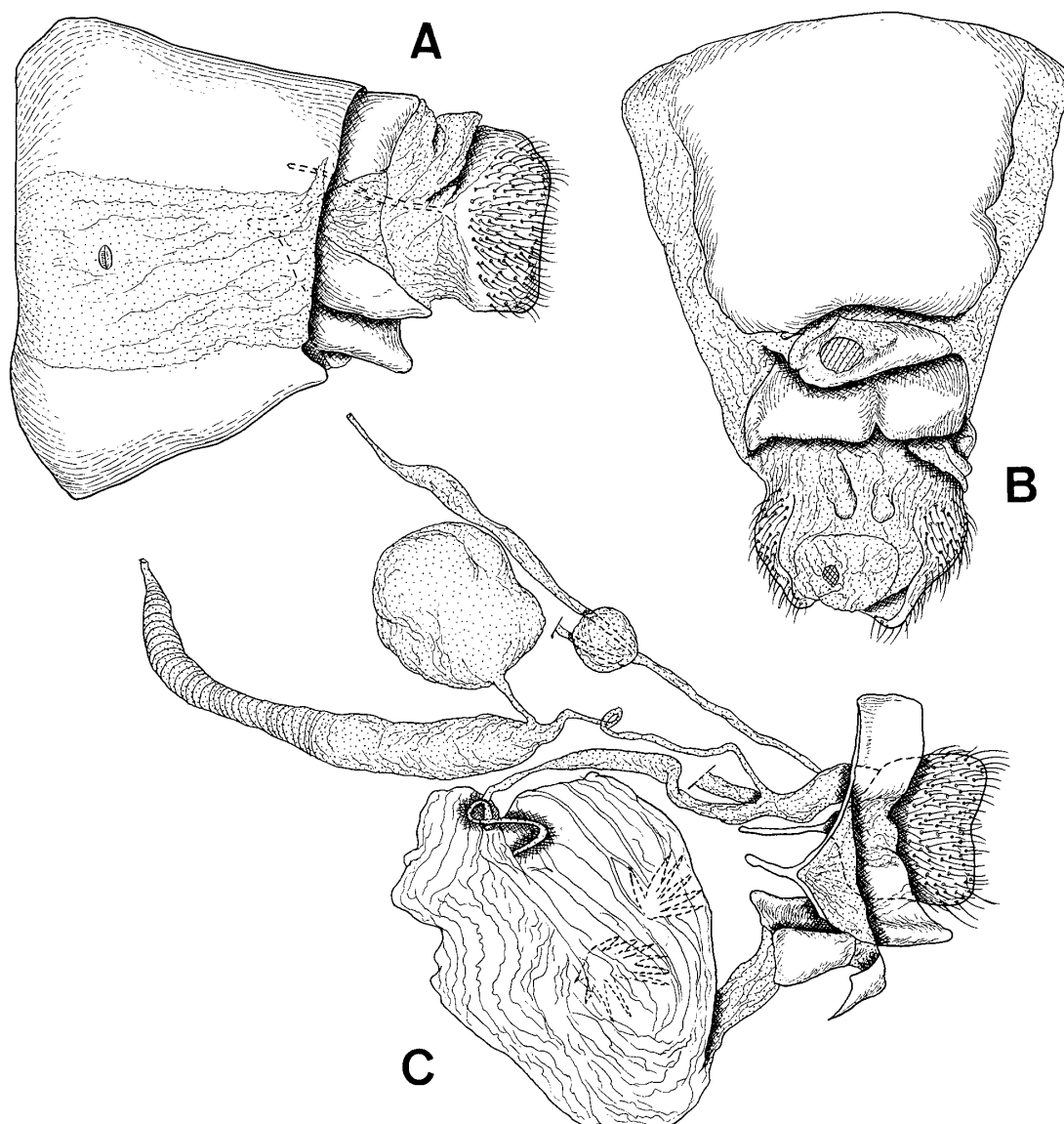


Fig. 5. Female external genitalia and internal reproductive organs of *Amerila astreus* (DRURY). A. External genitalia in lateral view; B. *Ditto* in ventral view; C. Internal reproductive organs in lateral view (left).

Female internal reproductive organs : Bursa copulatrix reaching to posterior $1/3$ of 6th segment. Antrum rather broad and its dorsal surface concave. Ductus bursae membranous and short, directing anteroventrally, $1/4$ as long as bursa copulatrix. Cervix bursae not developed. Corpus bursae membranous, globular in lateral view, $2/3$ as long as bursa copulatrix, with signa represented by a pair of echinoid sclerites bearing several strong spines. Bulla seminalis absent; ductus seminalis slender and long, arising from posterior $1/5$ of subdorsal portion of corpus bursae and attached to ventral surface of vestibulum. Spermatheca large and long. Glandula seivacea slender, with a globular sac at its forking point of it. No scent gland between 8th abdominal segment and papillae anales.

This genus may be closely related to the Afrotropical genus *Rhodogastria* (type species: *Phalaena amasis* CRAMER). Some authors such as HAMPSON (1901) and ROTHCHILD (1930) treated *Amerila* as a synonym of *Rhodogastria*. But I use tentatively *Amerila* for the Indo-Australian species in this paper, as I could not examine any Afrotropical species of *Rhodogastria*.

This genus is known from the Oriental Region from India to Taiwan, but most species have been recorded from New Guinea. Only slight differences are found in the genitalia among the species of this genus.

I examined the genitalia of the following species (species with asterisk are from zoogeographical regions other than the Palearctic and Oriental Regions.).

- *1. *Amerila arthusbertrand* (GUER., 1830) (Fig. 49H) (The female genitalia not examined.)

Lithosia arthusbertrand GUER., 1830, Voy Coquille lep.: 19.

Distribution: Sulu Is., New Guinea and Aru Is.

2. *Amerila astrus* (DRURY, 1773) (Figs. 4, 5, 49A, B)

Sphinx astreus DRURY, 1773, Illust. nat. Hist. exot. Insects, 2: index, 49, pl. 28, fig. 4.

Distribution: Indo-Australian Region.

- *3. *Amerila caudipennis* (WALKER, 1864) (Figs. 49C, D)

Cretonotos caudipennis WALKER, 1864, List Specimen lepid. Insects Colln Br. Mus., 31: 284.

Distribution: New Guinea.

- *4. *Amerila crokeri* (MACLEAY, 1827) (Figs. 49E, F)

Euprepia crokeri MACLEAY, 1827, King's Surv. Austr., 2: 465.

Distribution: New Guinea and Australia.

- *5. *Amerila nigropunctata* (BETHUNE-BAKER, 1908) (Fig. 49G)

Rhodogastria nigropunctata BETHUNE-BAKER, 1908, Novit. Zool., 15: 191.

Distribution: New Guinea.

4.1.2 The *Utetheisa* genus group

The *Utetheisa* genus group is distinctive in having the following autapomorphies. In male genitalia, vinculum with flexed part expanded ventromedially, valva with a scent bag, ampulla of valva with dorsal process, cucullus very large; in female genitalia, a large sclerotized depression present on the middle portion of the 6th–7th intersegmental membranous area.

The present genus group contains only *Utetheisa* HÜBNER, with many species distributed in the Indo-Australian, Afrotropical and Neotropical Regions.

4.1.2.1 Genus *Utetheisa* HÜBNER, [1819]

Utetheisa HÜBNER, [1819], Verz. bekannter Schmett.,: 168. Type species: *Phalaena ornatrix* LINNAEUS, 1758, by subsequent designation by KIRBY, 1892, Synonymic Cat. Lepid. Heterocera, 1: 345.

Uthetheisa: HÜBNER, [1824], Samml. exot. Schmett., 2: pl. (181). An incorrect subsequent spelling of *Utetheisa* HÜBNER, [1819].

Utethesia: MOORE, [1860], in HORSFIELD & MOORE, Cat. lepid. insects Mus. nat. Hist. East-India House, 2: 306. An incorrect subsequent spelling of *Utetheisa* HÜBNER, [1819].

Deiopeia CURTIS, 1827, Br. Ent., 4: 169. Type species: *Phalaena pulchella* LINNAERUS, 1758, by original designation.

Male external genitalia: Tegumen higher than vinculum in lateral view, in dorsal view broad at base and weakly narrowed posteriorly or narrowed towards posterior 1/2 then nearly parallel-sided on posterior 1/2, distinctly longer than uncus, anterodorsal portion strongly incised so that anterior margin V-shaped; acrotergite undeveloped. Fenestrula small, spot-like; a narrow to rather broad membranous slit between tegumen and uncus in lateral view. Uncus in dorsal view broadly rounded at base and becoming slender on middle 1/2, again broadened and sparsely short-haired on apical 1/4; in lateral view uncus strongly curved ventrally on basal 1/2, weakly or strongly expanded ventrolaterally towards tip, and sharply pointed at apex. Vinculum 1/2 as deep as ring, flexed part of vinculum expanded posteriorly and developed into a weakly sclerotized plate at anteroventral portion; saccus very small, flexed part of

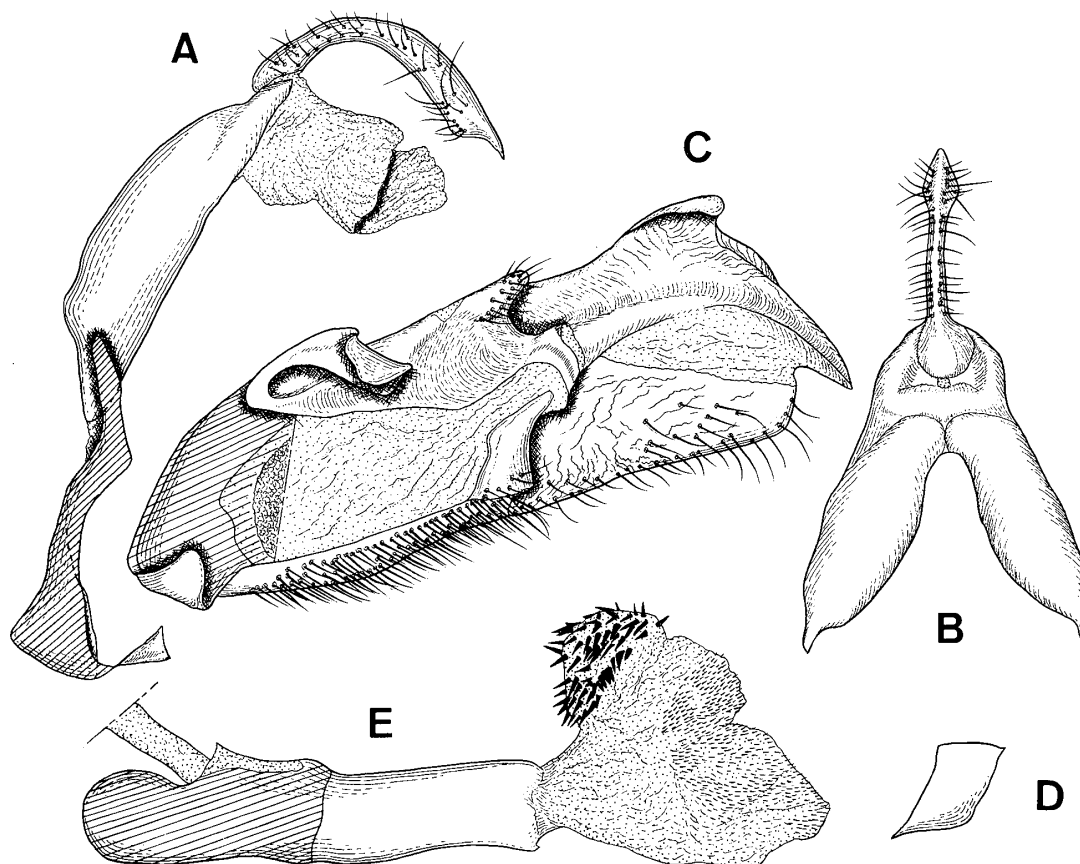


Fig. 6. Male external genitalia of *Utetheisa lotrix* (CRAMER). A. Ring in lateral view; B. Dorsum in dorsal view; C. Inside of right valva; D. Juxta in lateral view; E. Phallus in lateral view.

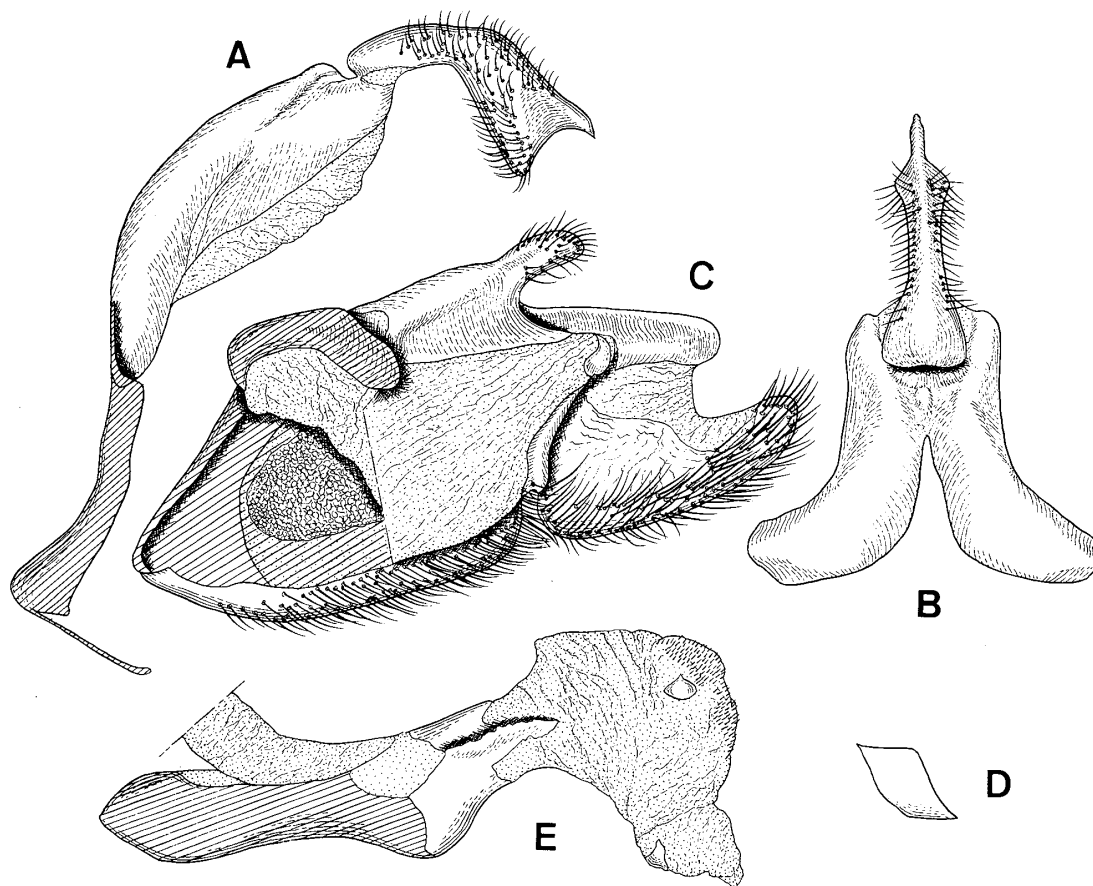


Fig. 7. Male external genitalia of *Utetheisa pulchelloides* HAMPSON. A. Ring in lateral view; B. Dorsum in dorsal view; C. Inside of right valva; D. Juxta in lateral view; E. Phallus in lateral view.

vinculum expanded posteriorly and developed into a weakly sclerotized plate at ventromedian portion. Valva large and provided with a pocket-like scent gland invaginated from a vertical slit of the middle portion of its outer wall; costa wide, ventral 1/2 weakly concaved; ampulla moderately large, with a short hairy clavate dorsal process at the middle; anellifer well developed; sacculus long and narrow, densely short-haired; transtilla long and narrow, elongated medially; cucullus large, 1/2 as long as valva, elongated posteriorly, acute or rounded distally; valvula well developed, dorsal 1/2 membranous, ventral 1/2 weakly sclerotized, with short hairs; harpe almost triangular. Juxta represented by a very small, V-shaped narrow horizontal plate. Phallus simple, short, and nearly straight; subzonal sheath less than 1/2 as long as aedeagus, without carina penis; coecum penis moderately long; vesica everted posteriorly or posteroventrally, about 1/2 as long as aedeagus, with irregular rows of many spinules on its posterior 1/2; in addition many distinct spines on its dorso-proximal surface in *lotrix*, and a pair of small lateral plates and a ventral plate in *pulchelloides*.

Female external genitalia: Seventh abdominal tergum and sternum well developed, sclerotized and separated from each other by narrow lateral membranous areas;

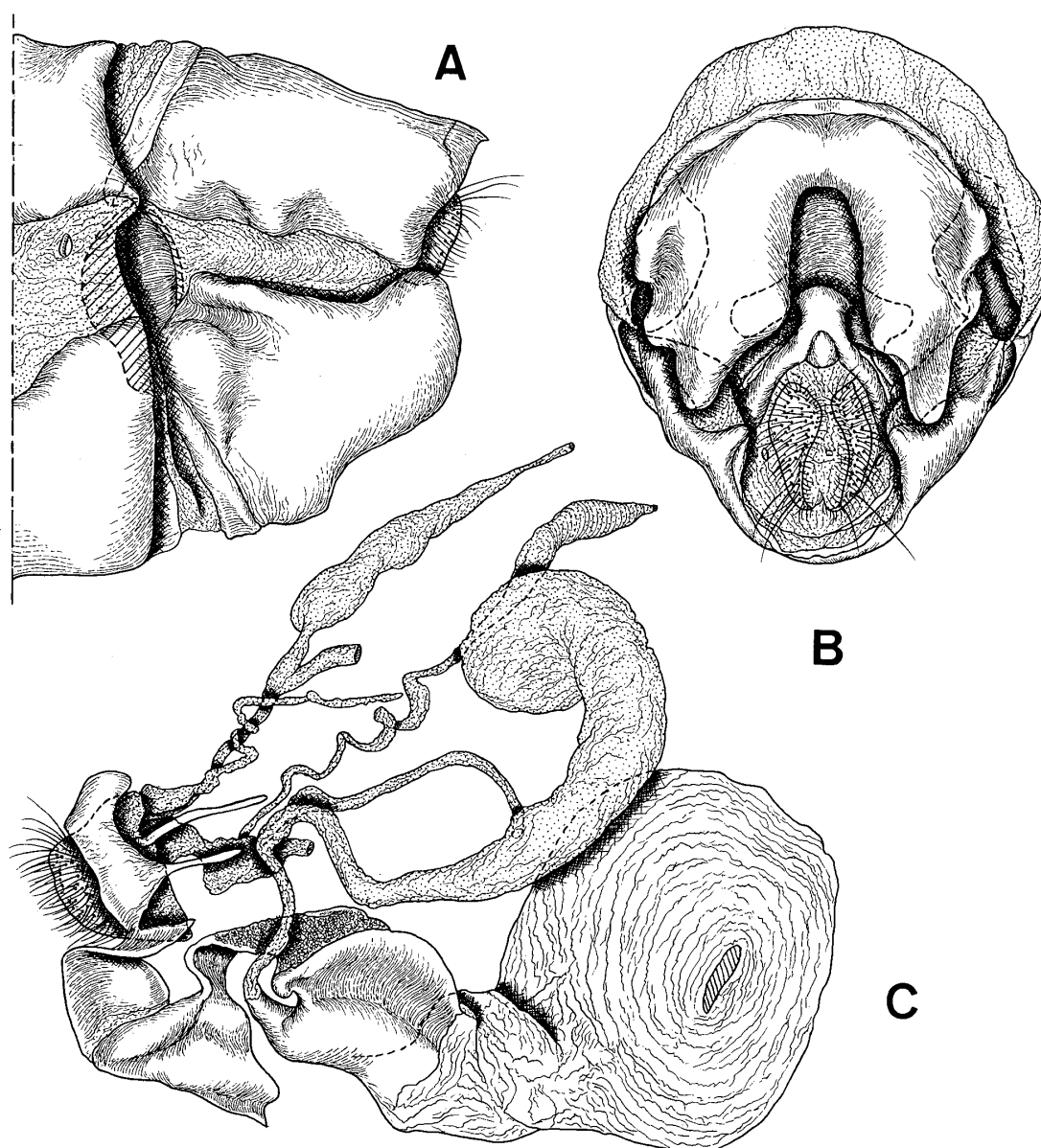


Fig. 8. Female external genitalia and internal reproductive organs of *Utetheisa lotrix* (CRAMER). A. External genitalia in lateral view ; B. *Ditto* in posteroventral view ; C. Internal reproductive organs in lateral view (right).

7th sternum with a posteromedial concavity which is continuous to copulatory cavity. A pair of large sclerotized depressions on lateral portions of 6th–7th intersegmental region. Eighth abdominal segment $1/2$ as high as 7th abdominal segment, uniformly sclerotized; sternal region and lamella postvaginalis completely united with each other and forming Y-shaped sclerite just behind ostium bursae. Ostium bursae reniform. Apophysis anterioris moderately long, nearly straight, $2/5$ as long as height of 8th segment. Papilla analis moderately large, semicircular, with many short hairs; apophysis posterioris slender, $1.5\times$ as long as apophysis anterioris.

Female internal reproductive organs : Bursa copulatrix reaching to posterior $1/5$

of posterior portion of 5th abdominal segment. Distinction of antrum and ductus bursae obscure; ductus bursae well sclerotized, broad and rather short, $1/3$ as long as bursa copulatrix, directed dorsally or posteriorly and then curved anteroventrally at middle. Cervix bursae strongly sclerotized with rounded dorsal margin and its middle portion strongly concaved. Corpus bursae membranous and globular, $1/2$ as long as bursa copulatrix, with signa represented by a pair of fusiform plates bearing some small spinules. Lower part of ductus seminalis slender, membranous except basal $1/8$, attached to posterior end of cervix bursae; bulla seminalis rather small, subequal in length to corpus bursae, weakly curved dorsally, broadened to rounded tip; upper part of ductus seminalis long and slender, arising from posterior $1/3$ of left lateral side of bulla seminalis and attached to dorsal surface of vestibulum. Spermatheca small. Glandula seviceae rather short, subequal in length to bursa copulatrix. Scent gland very long and twisted twice at the middle.

I examined the genitalia of the following species (species with asterisk are from zoogeographical regions other than the Palearctic and Oriental Region.).

1. *Utetheisa lotrix* (CRAMER, 1777) (Figs. 6, 8, 50C, D)
Geometra lotrix CRAMER, 1777, *Uitlandsche Kapellen* (Papillons exot.), 2: pl. 109, fig. E. F.
 Distribution: Indo-Australian Region.
- *2. *Utetheisa ornatix* (LINNAEUS, 1758) (Fig. 50A) (The female genitalia not examined.)
Phalaena ornatix LINNAEUS, 1758, *Syst. Nat.* (Edn 10), 1: 511.
 Distribution: Neotropical Region.
3. *Utetheisa pulchella* (LINNAEUS, 1758) (Fig. 50B)
Tinea pulchella LINNAEUS, 1758, *Syst. Nat.* (Edn 10), 1: 534.
 Distribution: Europe, Neotropical and Indo-Australian Regions.
4. *Utetheisa pulchelloides* HAMPSON, 1907 (Figs. 7, 50E, F)
Utetheisa pulchelloides HAMPSON, 1907, *Ann. Mag. nat. Hist.* (7) 19: 239.
 Distribution: Indo-Australian Region.

4.1.3 The *Callimorpha* genus group

The *Callimorpha* genus group is distinctive in having the following autapomorphies: In male genitalia, posterodorsal portion of manica well developed and produced to form theca posteriorly; in female genitalia, ductus bursae directing anterodorsally, lower part of ductus seminalis+bulla seminalis very large.

This genus group contains the following six genera, *Lacydes* WALKER, *Nikaea* MOORE, *Cymbalophora* RAMBUR, *Calpenia* MOORE, *Callimorpha* LATREILLE and *Aglaomorpha* gen. nov.

4.1.3.1 Genus *Lacydes* WALKER, 1855

Lacydes WALKER, 1855, *List Specimens lepid. Insects. Colln Br. Mus.*, 3: 685. Type species: *Eyprepia intercissa* FREYER, 1842, by monotypy.

E. intercissa is a junior subjective synonym of *Noctua spectabilis* TAUSCHER, 1806, *Mem. Soc. Nat. Univ. imp. Moscou*, 1: 212, fig.

Acymba RAMBUR, 1866, *Cat. syst. Lepid. Andalousia*, (2): 235. Type species: *Noctua spectabilis* TAUSCHER, 1806, by monotypy.

Palparctia SPULER, 1906, *Schment. Eur.*, 2: 133. Type species: *Noctua spectabilis* TAUSCHER, 1806, by monotypy.

Volgarctia ALPHERAKY, 1908, *Horae Soc. ent. Ross.*, 38: 606.

Type species: *Noctua spectabilis* TAUSCHER, 1806, by monotypy.

Male external genitalia: Tegumen in lateral view very large, slightly longer than uncus, separated into strongly sclerotized anterior portion and weakly sclerotized posterior portion; pedunculus narrow and moderately long; acrotergite slightly developed. Fenestrula appearing as a rather wide dorsomedian membranous spot, and a pair of rather broad lateral membranous slits on base of uncus. Uncus very large, sparsely haired, narrow at base and broadened to apical 1/3, with its tip appearing a

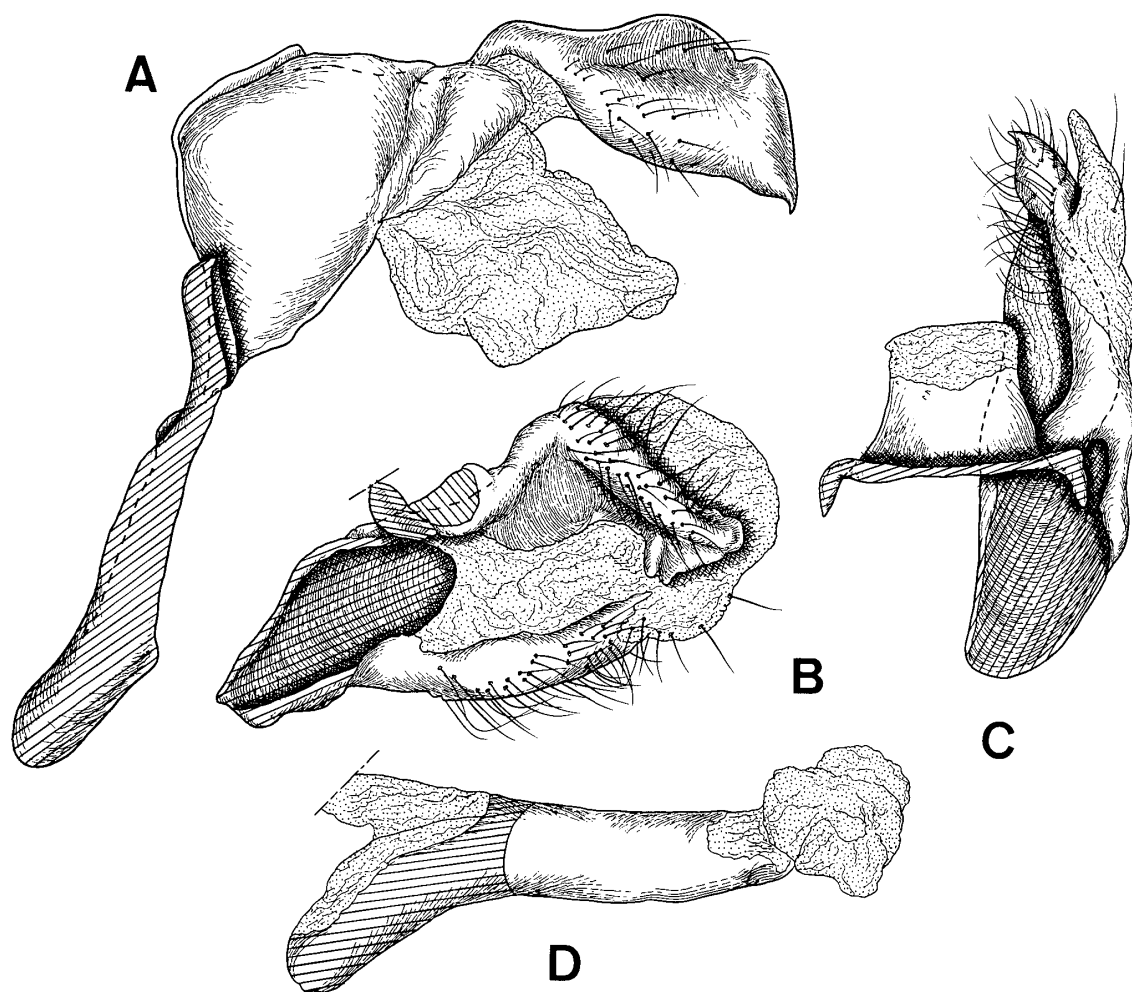


Fig. 9. Male external genitalia of *Lacydes spectabilis* (TAUSCHER). A. Ring in lateral view; B. Inside of right valva; C. Theca and left valva in dorsal view; D. Phallus in lateral view.

hook-like process. Vinculum long and slender, $1/2$ as deep as ring ; saccus moderately long. Valva moderate in size, near oval in shape ; costa fused with harpe + ampulla to form a large sclerite, arched dorsally at middle, ventral portion of this sclerite strongly excavated, its posterior $1/2$ long and slender, bearing several long hairs throughout on its inner surface ; anellifer rather broad, occupying central $1/3$ of basal area of inner wall ; sacculus rather broad and long, bearing long hairs ; valvula broad, occupying apical $1/3$ of valva. Juxta nearly rectangular. Theca well developed, projected posteriorly, basal $2/3$ sclerotized and posterior $1/3$ membranous. Phallus short and simple, nearly straight ; suprazonal sheath $2/3$ as long as aedeagus, without carina penis ; dorsal $1/3$ of subzonal sheath membranous ; vesica simple, everted posteriorly, without cornutus.

This genus was hitherto considered to be more closely related to *Spilosoma* and its allies than to *Callimorpha*, and assigned to the Spilosomatinae (SEITZ, 1910). But the male genitalia of this genus clearly show that they are not only similar to those of *Callimorpha* in the fundamental structure but also have all the autapomorphies of the *Callimorpha* genus group. In the *Callimorpha* genus group *Lacydes* is characteristic in the strongly developed tegumen and uncus of the male genitalia.

I examined the male genitalia of the following species.

1. *Lacydes spectabilis* (TAUSCHER, 1806) (Figs. 9. 50G)

Noctua spectabilis TAUSCHER, 1806, *Mem. Soc. Nat. Univ. imp. Moscou*, 1 : 212, fig.

Distribution : From Central Russia to Syria eastward through Anterior Asia to the Altai.

4.1.3.2 Genus *Nikaea* MOORE, 1879

Nikaea MOORE, 1879, in HEWITSON & MOORE, *Descr. new Indian lepid. Insects. Colln. late Mr. W. S.*

ATKINSON, (1) : 11. Type species : *Hypercompa longipennis* WALKER, 1855, by monotypy.

Nicaea HAMPSON, 1901, *Cat. Lepid. Phalaenae Br. Mus.*, 3 : xi, 5. 218.

An unjustified emendation of *Nikaea* MOORE, 1879.

A junior homonym of *Nicaea* ROBINEAU-DESVOIDY, 1863, -*Insecta*, *Diptera*. The objective replacement name is *Nikaea* MOORE, 1879.

Male external genitalia : Tegumen in lateral view very long and narrow, slightly longer than uncus ; pedunculus short ; acrotergite undeveloped. Fenestrula appearing as a small membranous spot ; membranous slits between tegumen and uncus absent. Uncus very long and slender, weakly curved ventrally, gently tapering to the apex. Vinculum rather broad, $2/5$ as deep as ring ; saccus moderately long. Valva very large, subdivided into strongly sclerotized dorsal and ventral parts, and membranous median anellifer ; dorsal part composed of costa, harpe and ampulla which are fused with each other ; basal portion of dorsal part strongly concaved, with several long hairs, apical $1/2$ produced distally into a broad lamellate process which tapers to apex, weakly curved ventrally, and is clothed with many hairs ; anellifer rather broad and long ; sacculus very wide and long, bearing many stiff hairs on its ventral margin ; valvula slightly developed, situated on posteroventral margin of valva ; transtilla

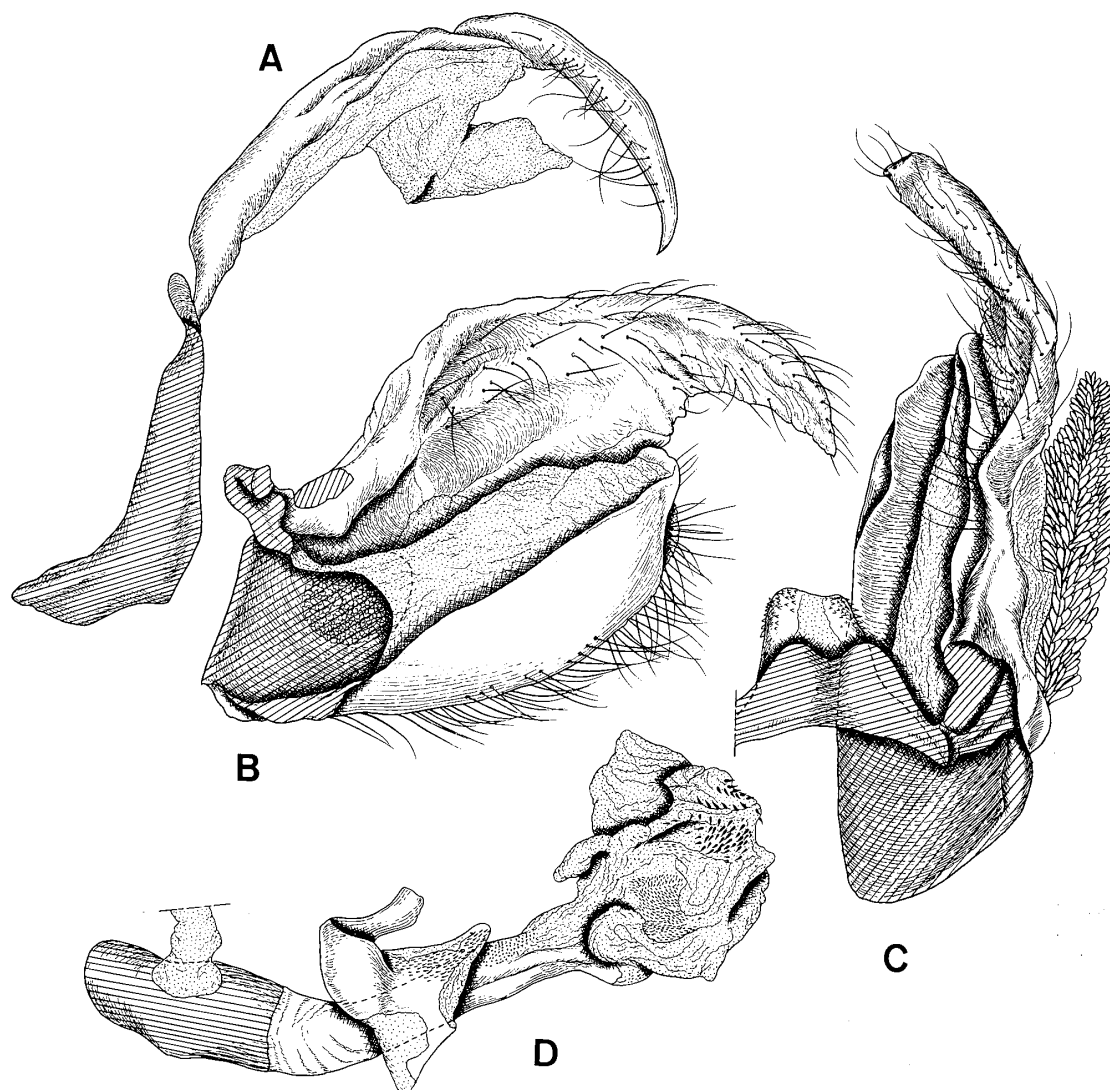


Fig. 10. Male external genitalia of *Nikaea longipennis* (WALKER). A. Ring in lateral view ; B. Inside of right valva ; C. Theca and left valva in dorsal view ; D. Phallus and theca in lateral view.

broad, produced to form a dorsal bridge which is projected posteriorly at the middle ; base of outer wall of valva bearing a long membranous lobe which is densely clothed with many small papillae on its entire surface. Juxta nearly trapezoid. Theca well developed, membranous on its middle portion and strongly sclerotized on lateral portions, which bear minute spinules on its distal corners. Phallus modelately long ; suprazonal sheath weakly curved dorsally, densely bearing minute spinules on dorsal surface of its posterior $1/2$; subzonal sheath $1/3$ as long as aedeagus ; coecum penis developed ; vesica everted dorsally, $2/5$ as long as aedeagus, with a group of many distinct spines dorsally and a congregation of minute spinules left laterally.

This genus is distinctive in having the following characters : Very large sacculus

of male valva and a long membranous lobe of outer wall of valva densely clothed with many small papillae on the entire surface.

I examined the male genitalia of the following species.

1. *Nikaea longipennis* (WALKER, 1855) (Figs. 10, 51A, B)

Hypercompa longipennis WALKER, 1855, List Specimens lepid. Insects Colln Br. Mus., **3**: 655.

Distribution: Eastern Himalaya, China, Taiwan and Japan (Ishigaki Is. and Iriomote Is. of the Ryukyus.)

4.1.3.3 Genus *Cymbalophora* RAMBUR, 1866

Cymbalophora RAMBUR, 1866, Cat. syst. Lepid. Andalousie, (2): 231. Type species: *Phalaena pudica* ESPER, 1785, by monotypy.

Tympanophora FABOULBENE, 1865, *Annls Soc. ent. Fr.*, (4) **4**: 704.

Type species: *Phalaena pudica* ESPER, 1785, by monotypy.

A junior homonym of *Tympanophora* WHITE, 1841, in GREY, J. Exped. Austral., **2**: 468. -Insecta, Orthoptera.

Male external genitalia: Genitalia small. Tegumen in lateral view rather small, separated into strongly sclerotized anterior part and weakly sclerotized posterior part by a weakly sclerotized median zone, with several short hairs on ventral 1/2; pedunculus rather short and slender; acrotergite weakly developed. Uncus accidentally broken in the examined genitalia. Fenestrula appearing as a small membranous spot. Vinculum long and moderately wide, 1/2 as deep as ring; saccus rather small, its dorsal 1/2 membranous. Valva moderate in size; costa completely united with harpe+ampulla, basal 1/3 of the combined area strongly concaved medially, its posterior 2/3 produced distally into a broad elongate process, straight, tapered and gently curved ventrally on its distal 1/2; transtillae produced to form a dorsal bridge; anellifer rather broad, occupying central 1/2 of basal area of valva; sacculus long and slender, with many stiff long hairs on its ventral margin; valvula 2/5 as long as valva, with many long hairs on its posteroventral margin. Juxta being a V-shaped horizontal sclerite, of which dorsal arms narrow and expand anteriorly to succuli. Theca well developed, rectangular in dorsal view, membranous dorsoproximally, with dense minute spinules on its posterior 1/2. Phallus thick and long, straight; suprazonal sheath weakly sclerotized, without carina penis; subzonal sheath 1/2 as long as aedeagus; coecum penis moderately long; vesica simple, everted posteroventrally, with many minute spinules on dorsal surface.

Although the general appearance of adult is considerably different from *Callimorpha* and its allies, the male genitalia of this genus show every autapomorphic characters of the *Callimorpha* genus group. As I could not find the apomorphic character present only in this genus, so strict monophyly of this genus is not determined. But this genus seems to be related to the following two genera in the structure of the male genitalia.

I examined the male genitalia of the following species.

1. *Cymbalophora pudica* (ESPER, 1785) (Figs. 11, 50H)
Phalaena pudica ESPER, 1785, Die Schmett. 3: 177, pl. 33, fig. 1.
Distribution: South Europe and Mauretania.

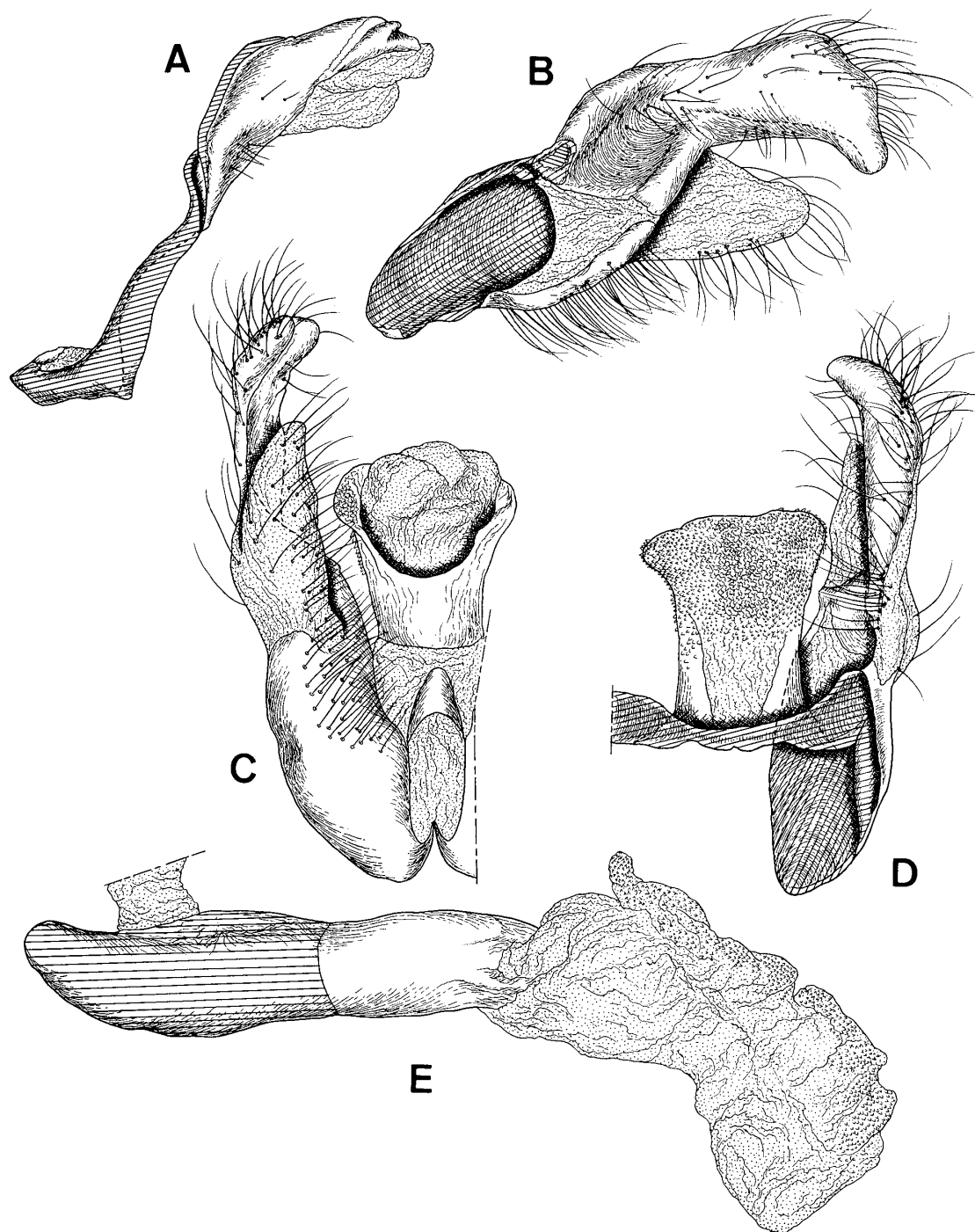


Fig. 11. Male external genitalia of *Cymbalophora pudica* (ESPER). A. Ring in lateral view; B. Inside of right valva; C. Left valva, juxta and phallus in ventral view; D. Theca and left valva in dorsal view; E. Phallus in lateral view.

4.1.3.4 Genus *Calpenia* Moore, 1872

Calpenia MOORE, 1872, *Proc. zool. Soc. Lond.*, 1872: 571. Type species: *Calpenia saundersi* MOORE, 1872, by monotypy.

Male external genitalia: Tegumen in lateral view rather broad and long, slightly longer than uncus; pedunculus very narrow and long; acrotergite undeveloped. Fenestrula appearing as a small membranous spot; lateral membranous slits between tegumen and uncus absent. Uncus moderately long, slightly curved ventrally, tapered

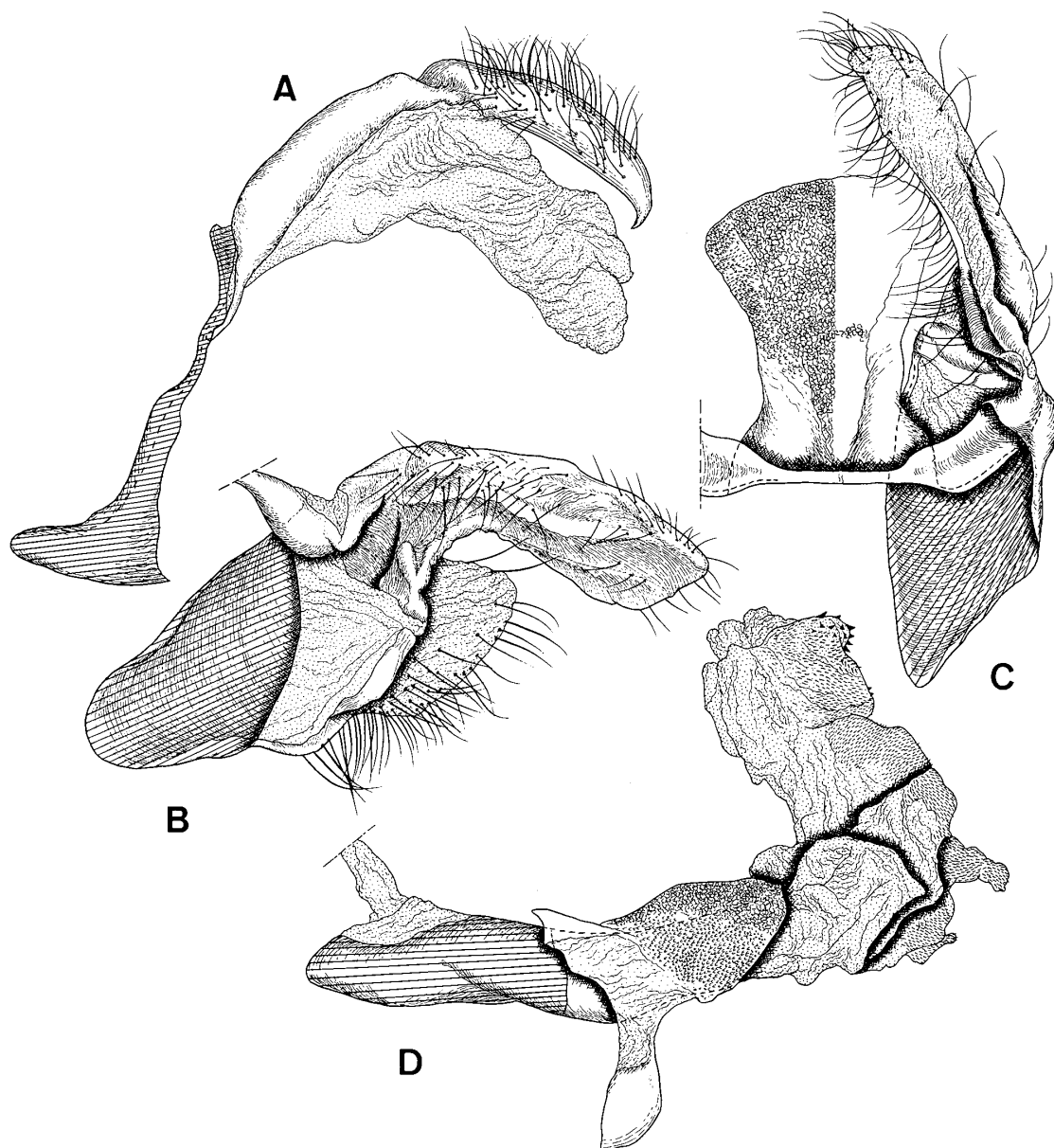


Fig. 12. Male external genitalia of *Calpenia zerenaria* (OBERTHUR). A. Ring in lateral view; B. Inside of right valva; C. Theca and left valve in dorsal view; D. Phallus, theca and juxta in lateral view.

towards sharply pointed tip, sparsely haired on its lateral surfaces. Vinculum long and slender, $1/2$ as high as ring; saccus moderately developed. Valva large; costa fused with harpe+ampulla to form a sparsely haired composite sclerite, of which distal $2/3$ is produced distally into an arched bluntly ended process; anellifer triangular and occupying basal $1/2$; sacculus long and slender, strongly curved posterodorsally at basal $1/4$, with several stiff hairs on its ventral margin; valvula well developed, as wide as anellifer. Juxta being a rather short V-shaped horizontal sclerite. Theca well developed, widened distally, densely covered with minute spinules, weakly desclerotized dorsodistally. Phallus nearly straight; suprazonal sheath $1/2$ as long as aedeagus, without carina penis; coecum penis small; vesica everted dorsally, with a group of several small spines and numerous spinules evenly distributed on distal surface of everted vesica.

This genus seems to be closely related to *Callimorpha* in the structure of the male genitalia, which are almost identical with those of *Callimorpha* in every structure except for dorsally everted vesica.

I examined the male genitalia of the following species.

1. *Calpenia takamukui* MATSUMURA, 1930 (Fig. 51C)
Calpenia takamukui MATSUMURA, 1930, *Ins. Mats.*, 5 (1, 2): 32.
 Distribution: China and Taiwan.
2. *Calpenia zerenalia* (OBERTHÜR, 1886) (Figs. 12, 51D)
Euprepia zerenalia OBERTHÜR, 1886, *Et. Ent.*, 2: 30, pl. 3, fig. 17.
 Distribution: China.

4.1.3.5 Genus *Callimorpha* LATREILLE, 1809

Callimorpha LATREILLE, 1809, *Genera Crust. Insect.*, 4: 220. Type species: *Phalaena dominula* LINNAEUS, 1758, by subsequent designation by DESMAREST, 1857, in Chenu, *Encycl. Hist. nat. (Papillons nocturnes)*: 33.

Panaxia TAMS, 1939, *Entomologist*, 72: 73. Type species: *Phalaena dominula* LINNAEUS, 1758, by original designation.

Male external genitalia: Tegumen in lateral view usually slender and long; in *quadripunctaria* dorsal $1/2$ of tegumen very narrow and produced to form a pair of small swellings on posterodorsal end; pedunculus short and rather thick; acrotergite usually undeveloped but in *albipuncta* slightly developed. Fenestrula rather wide; usually without lateral membranous slits anterior to uncus except in *dominula* and *quadripunctaria*. Uncus usually slender and moderately long (in *similis* very slender and long), nearly straight or slightly curved ventrally, tapered towards tip which is sharply pointed, with sparse short hairs. Vinculum rather short, about $2/5$ as deep as ring; saccus usually developed, in *similis* well developed and large but in *albipuncta* rather small. Valva large, clothed with dense stiff hairs on its ventral margin; costa fused with harpe+ampulla and to form a large sclerite, basal portion of this sclerite weakly or strongly excavated at middle, apical portion variable in shape but always produced distally as a large process beyond tip of valvula; anellifer triangular, occupying basal

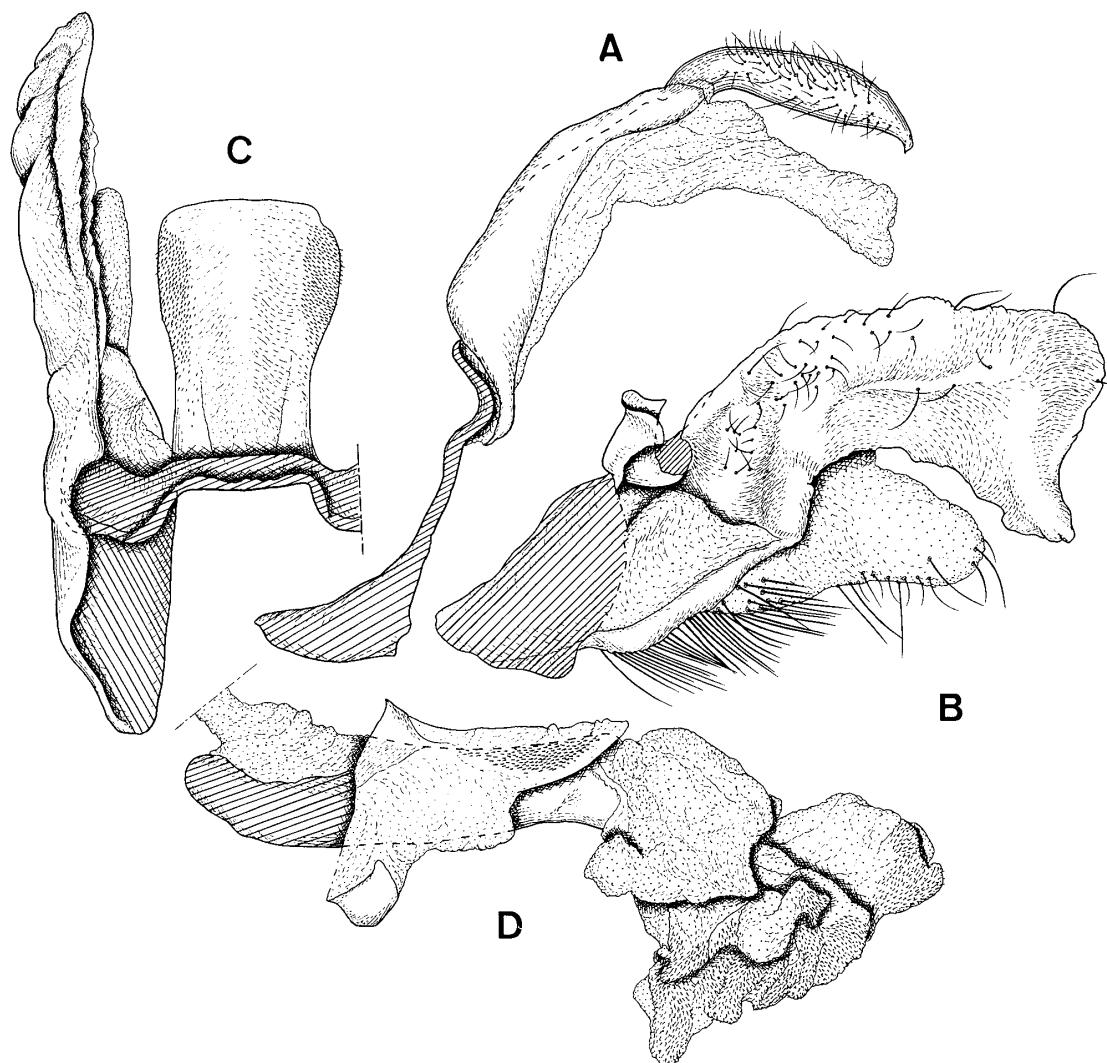


Fig. 13. Male external genitalia of *Callimorpha deminula* (LINNAEUS). A. Ring in lateral view ; B. Inside of right valva ; C. Theca and right valva in dorsal view ; D. Phallus, theca and juxta in lateral view.

1/3 of valva ; saccus long and narrow ; transtilla well developed, elongated inwardly and united with each other ; valvula well developed, 1/3 – 1/2 as long as valva. Juxta of a weakly sclerotized V-shaped horizontal sclerite, nearly rectangular in lateral view. Theca well developed, wide and protruding posteriorly, truncate distally, widely membranous dorsodistally, sometimes covered with minute spinules laterally. Phallus thick and long, nearly straight ; suprazonal sheath usually straight but in *albipuncta* weakly curved dorsally, without carina penis ; subzonal sheath about 1/2 as long as aedeagus, in *albipuncta* rather short and 2/5 as long as aedeagus ; coecum penis usually developed ; vesica everted posteriorly or posteroventrally, with some congregations of numerous spinules, but in *similis* and *principalis* bearing many small but distinct spines on its apical portion.

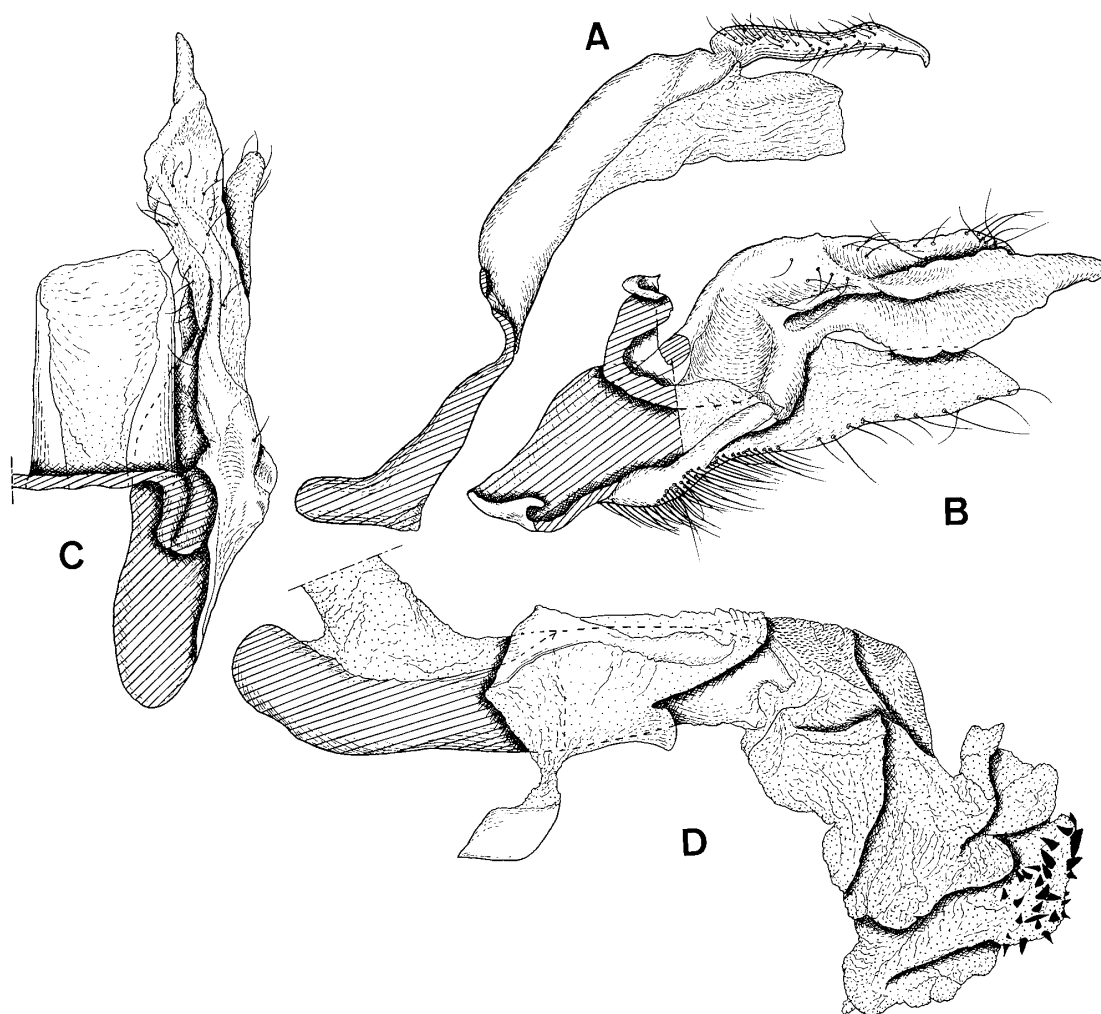


Fig. 14. Male external genitalia of *Callimorpha principalis* (KOLLER). A. Ring in lateral view; B. Inside of right valva; C. Theca and left valva in dorsal view; D. Phallus, theca and juxta in lateral view.

Female external genitalia: Seventh abdominal tergum and sternum large and well sclerotized. Posterior 1/2 of lateral membranous areas of 7th segment rather thick, strongly concaved and with wrinkles and folds (in *albipuncta* the concavity forming a large invagination anteriorly). Eighth abdominal segment 1/2 as high as 7th abdominal segment; its tergum well sclerotized; its sternum separated bilaterally into a pair of sternites; broad membranous area present between lamella postvaginalis and 8th abdominal sternites. Lamella antevaginalis very wide, completely fused with lamella postvaginalis laterally to form a genital cavity, weakly concaved and bulged at middle in ventral view. Ostium bursae large and triangular, wider than long, its sides only strongly raised. Apophysis anterioris nearly straight and moderately long, 1/3 as long as height of 8th abdominal segment. Papilla analis small and nearly triangular, with dense short hairs; apophysis posterioris slender, slightly shorter than apophysis anterioris.

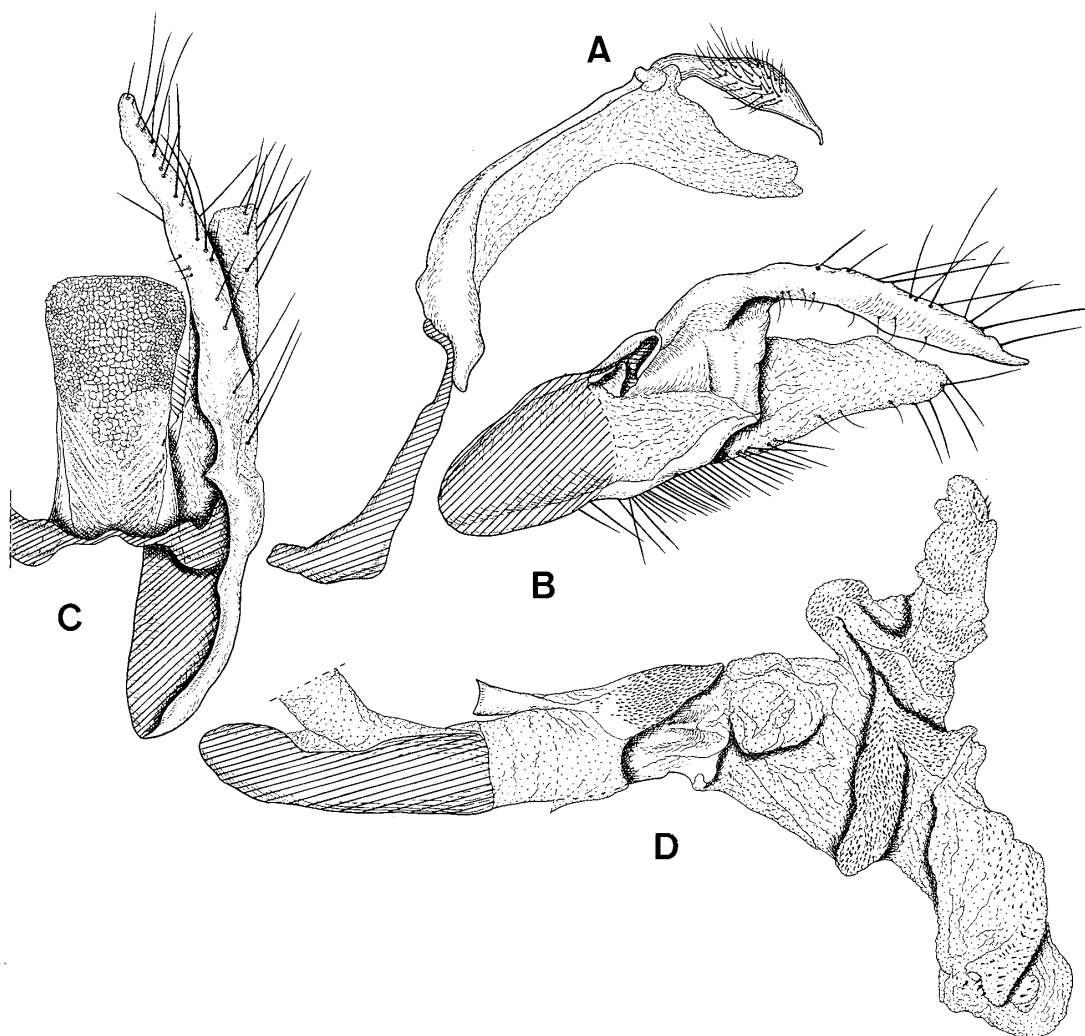


Fig. 15. Male external genitalia of *Callimorpha quadripunctaria* (PODA). A. Ring in lateral view; B. Inside of right valva; C. Theca and left valva in dorsal view; D. Phallus and theca in lateral view.

Female internal reproductive organs: Bursa copulatrix reaching to posterior $1/2$ of 6th abdominal segment. Antrum rather broad and short. Ductus bursae rather short, weakly sclerotized and gutter-shaped, directing anterodorsally, $1/6 - 1/5$ as long as bursa copulatrix. Cervix bursae well developed and sclerotized, with many irregular rows of furrows on its entire surface. Corpus bursae large and oval, with many regular rows of longitudinal streaks on its entire surface, nearly $1/2$ as long as bursa copulatrix; signa represented by four slender sclerotized bands. In most species of this genus, lower part of ductus seminalis+bulla seminalis very large, subequal in length to bursa copulatrix, attached to posterior $1/2$ of ventral portion of cervix bursae. In *quadripunctaria* lower part of ductus seminalis very slender and short, attached to posterior $1/3$ of right lateral side of cervix bursae; bulla seminalis small and globular. Upper part of ductus seminalis rather long and slender, attached to dorsal portion of vestibulum. Spermatheca rather small. Glandula seviceae small.

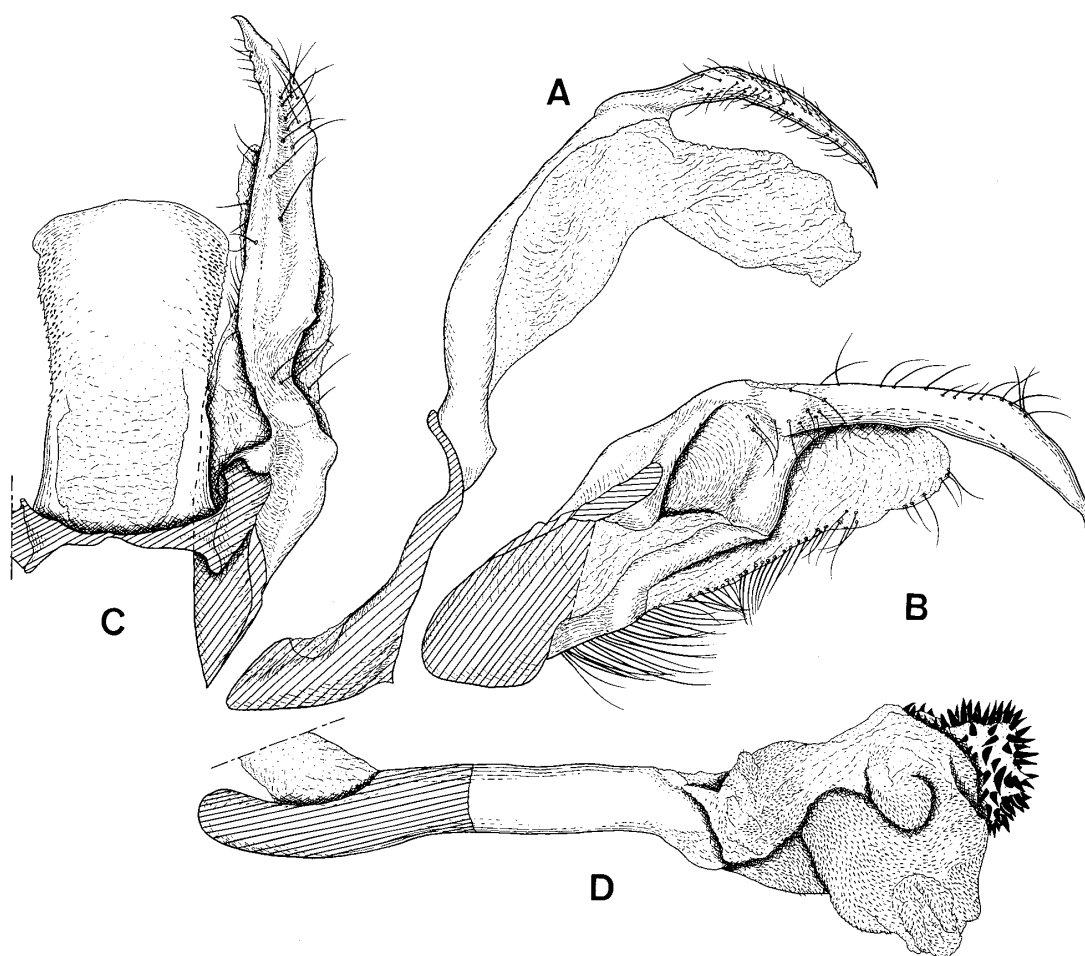


Fig. 16. Male external genitalia of *Callimorpha similis* (MOORE). A. Ring in lateral view ; B. Inside of right valva ; C. Theca and left valva in dorsal view ; D. Phallus in lateral view.

Scent gland slender and simple.

This genus seems to be closely related to the genus *Calpenia* in the structure of the male genitalia. The difference of the male genitalia between the two genera is found only in the direction of the everted vesica. This genus is characteristic in having the concavities on posterior 1/2 of the lateral membranous areas of the female 7th abdominal segment, which are not confirmed in *Calpenia* owing to paucity of female material.

I examined the genitalia of the following species.

1. *Callimorpha albipuncta* WILEMAN, 1910 (Figs. 1, 17, 51E, F)
Callimorpha albipuncta WILEMAN, 1910, *Entomologist*, **43**: 137.
 Distribution: Taiwan.
2. *Callimorpha dominula* (LINNAEUS, 1758) (Figs. 13, 18, 51G, H)
Phalaena dominula LINNAEUS, 1758, *Syst. Nat.*, (Edn 10) **1**: 509.
 Distribution: Throughout Europe with exception of the arctic countries and many

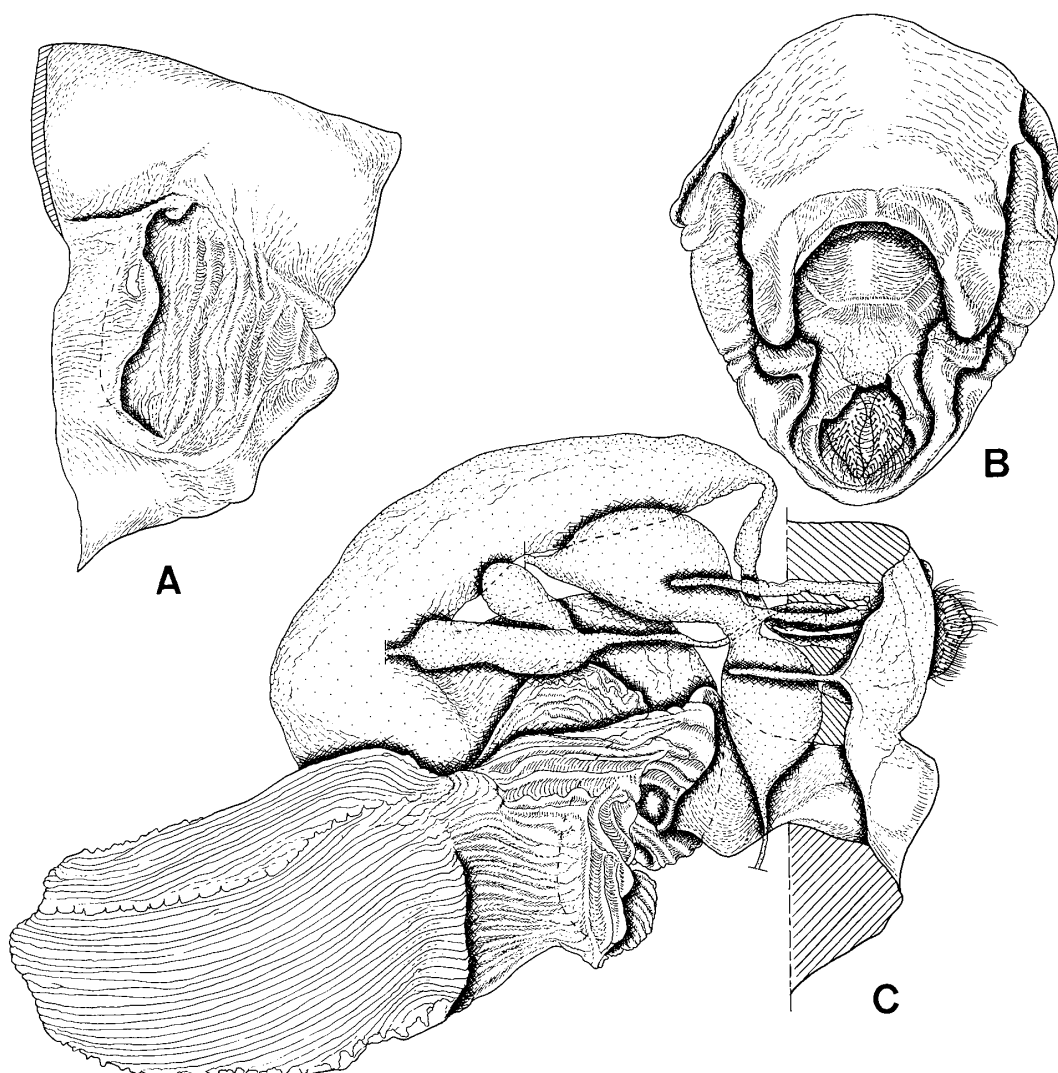


Fig. 17. Female external genitalia and internal reproductive organs of *Callimorpha albipuncta* WILEMAN. A. Seventh abdominal segment in lateral view ; B. External genitalia in posteroventral view ; C. Internal reproductive organs in lateral view (left).

islands, eastwards to the countries around the Black Sea.

3. *Callimorpha principalis* (KOLLER, 1844) (Figs. 15, 19, 52E – G)
Euprepia principalis KOLLER, 1844, in HUQEL, *Kaschmir.*, 4 (2) : 265, pl. 20, fig. 2.
 Distribution : Himalayas, Sikkim and China.
4. *Callimorpha quadripunctaria* (PODA, 1761) (Figs. 15, 20, 52A, B)
Noctua quadripunctaria PODA, 1761, *Ins. Mus. Graec.* : 89.
 Distribution : Throughout Europe from England and Western France to Iran and Leningrad to Mediterranean, also in North and Western Asia.
5. *Callimorpha similis* (MOORE, 1879) (Figs. 2, 16, 52C, D)
Hypercompa similis MOORE, 1879, *Proc. zool. Soc. Lond.*, 1879 : 397.
 Distribution : Sikkim and Nepal.

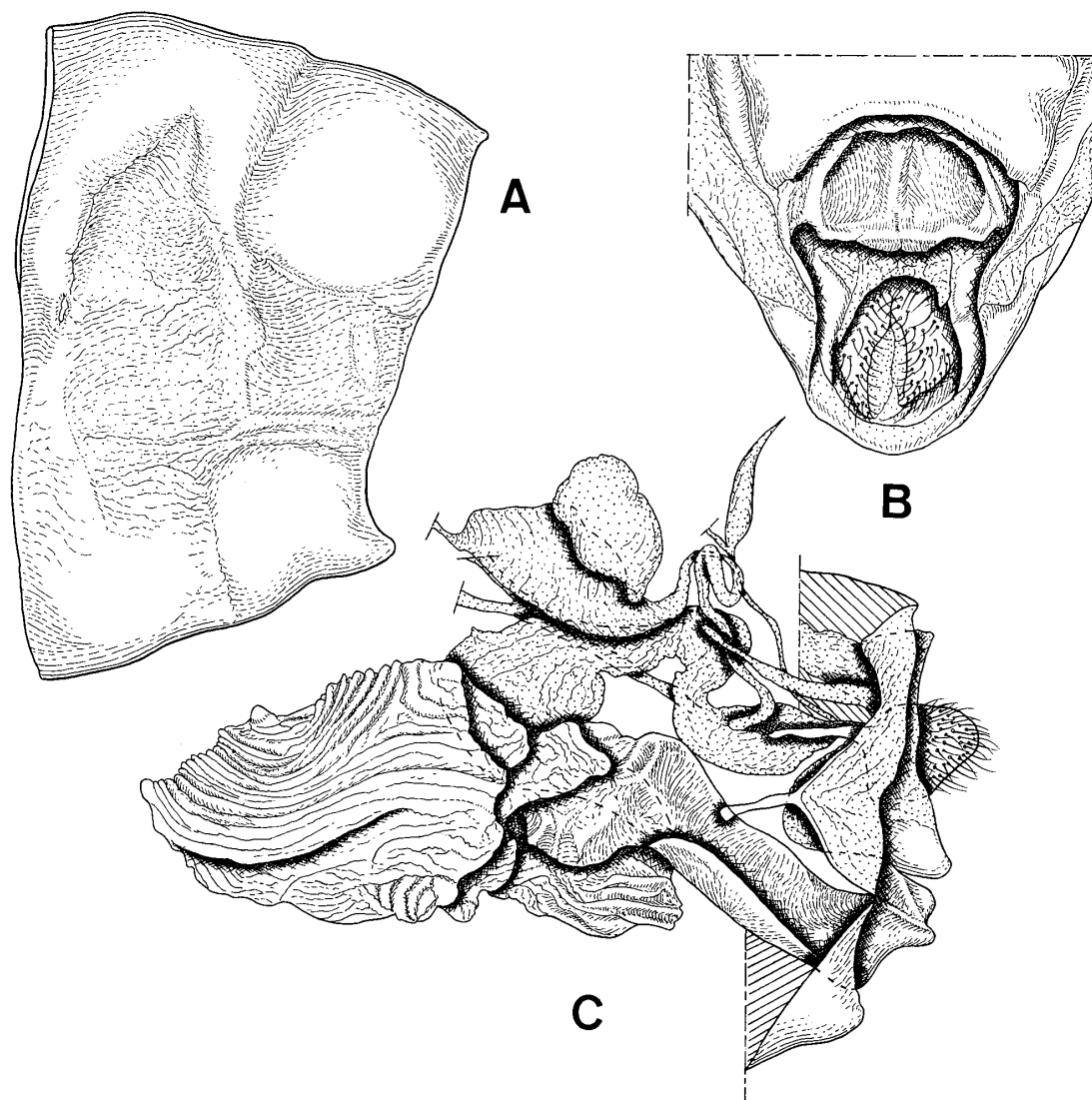


Fig. 18. Female external genitalia and internal reproductive organs of *Callimorpha dominula* (LINNAEUS). A. Seventh abdominal segment in lateral view ; B. External genitalia in posteroventral view ; C. Internal reproductive organs in lateral view (left).

4.1.3.6 Genus *Aglaomorpha* KÔDA, gen. nov.

Type species : *Hypercompa histrio* WALKER, 1855.

Head : Frons slightly swollen, subequal in width to compound eyes in frontal view, scaling smooth. Antenna slightly shorter than $1/2$ length of fore wing ; flagellum consisting of 65 – 70 segments, clothed with minute hairs on each segment which has a pair of longer sensory hairs apically. Labial palpus upturned, its tip reaching to $1/2$ level of frons ; 1st segment subequal in length to 2nd ; 3rd segment $1/3$ as long as 2nd. Maxillary palpus 2-segmented, 2nd segment very short and rudimentary.

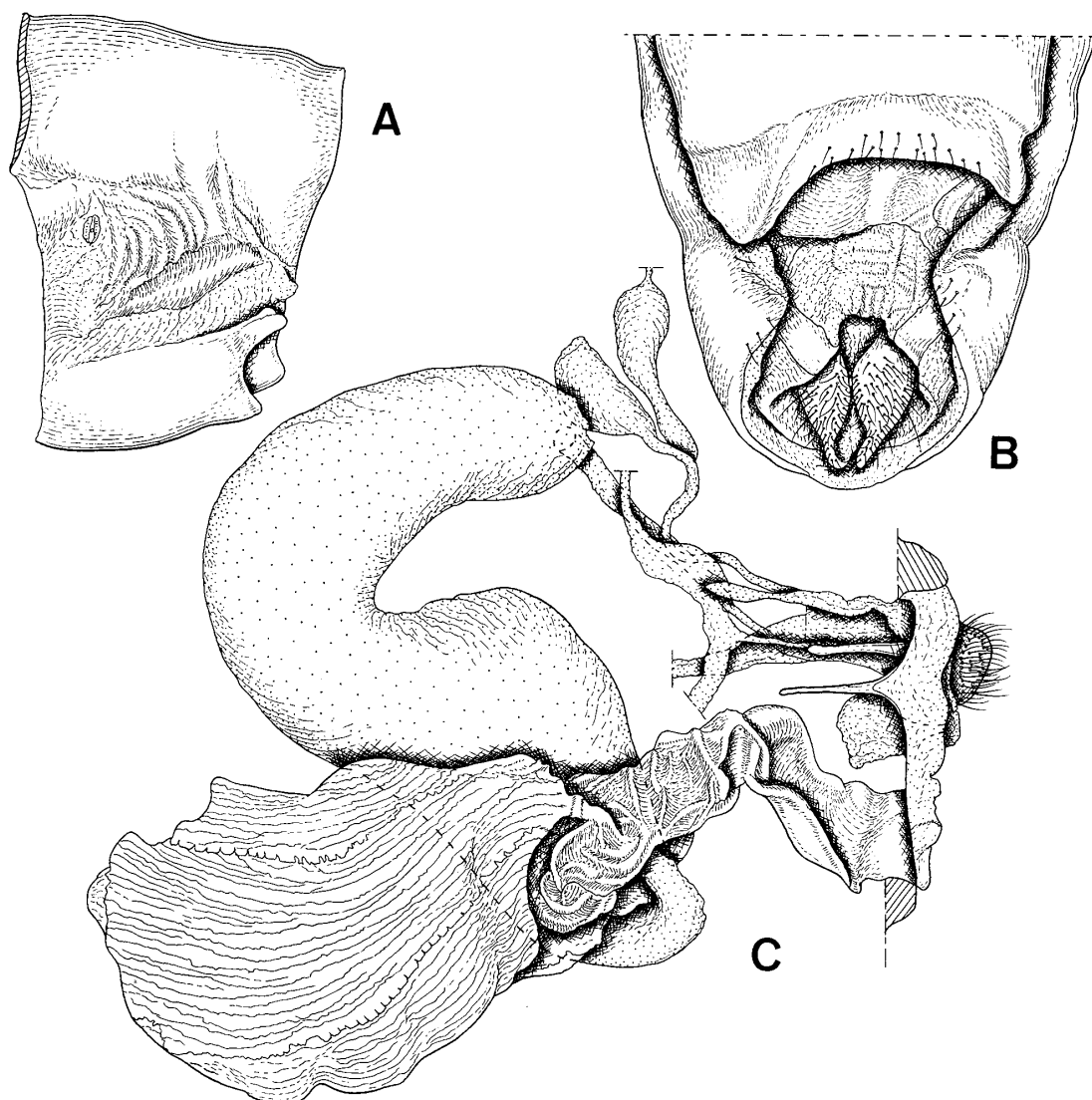


Fig. 19. Female external genitalia and internal reproductive organs of *Callimorpha principaris* (KOLLER). A. Seventh abdominal segment in lateral view ; B. External genitalia in ventral view ; C. Internal reproductive organs in lateral view (left).

Thorax : Patagia large, quadrate and its margin rounded.

Legs. Fore leg : Trochanter $\frac{1}{5}$ as long as tibia ; tibia $\frac{3}{5} - \frac{2}{3}$ as long as femur ; epiphysis $\frac{1}{3} - \frac{1}{2}$ as long as tibia and situated on its basal $\frac{1}{5} - \frac{2}{5}$. Mid leg : Trochanter $\frac{1}{5}$ as long as tibia ; tibia $\frac{4}{5}$ as long as femur ; anterior terminal spur $\frac{1}{5}$ as long as tibia ; posterior one $\frac{1}{6}$ as long as tibia. Hind leg : Trochanter $\frac{1}{12} - \frac{1}{10}$ as long as tibia ; tibia $1.2\times$ as long as femur ; median spurs situated on apical $\frac{1}{5}$ of tibia ; anterior median spur $\frac{1}{7} - \frac{1}{6}$, posterior median spur $\frac{1}{10}$, anterior terminal spur $\frac{1}{6} - \frac{1}{4}$, posterior terminal spur $\frac{1}{10} - \frac{1}{5}$ as long as tibia.

Wing venation : Fore wing long and narrow ; vein 3 from before lower angle of discoidal cell ; 4 and 5 from lower angle ; 6 and common stem of 7, 8, 9 and 10 from upper angle ; 7 and common stem of 8, 9 and 10 stalked first, then 10 branched from

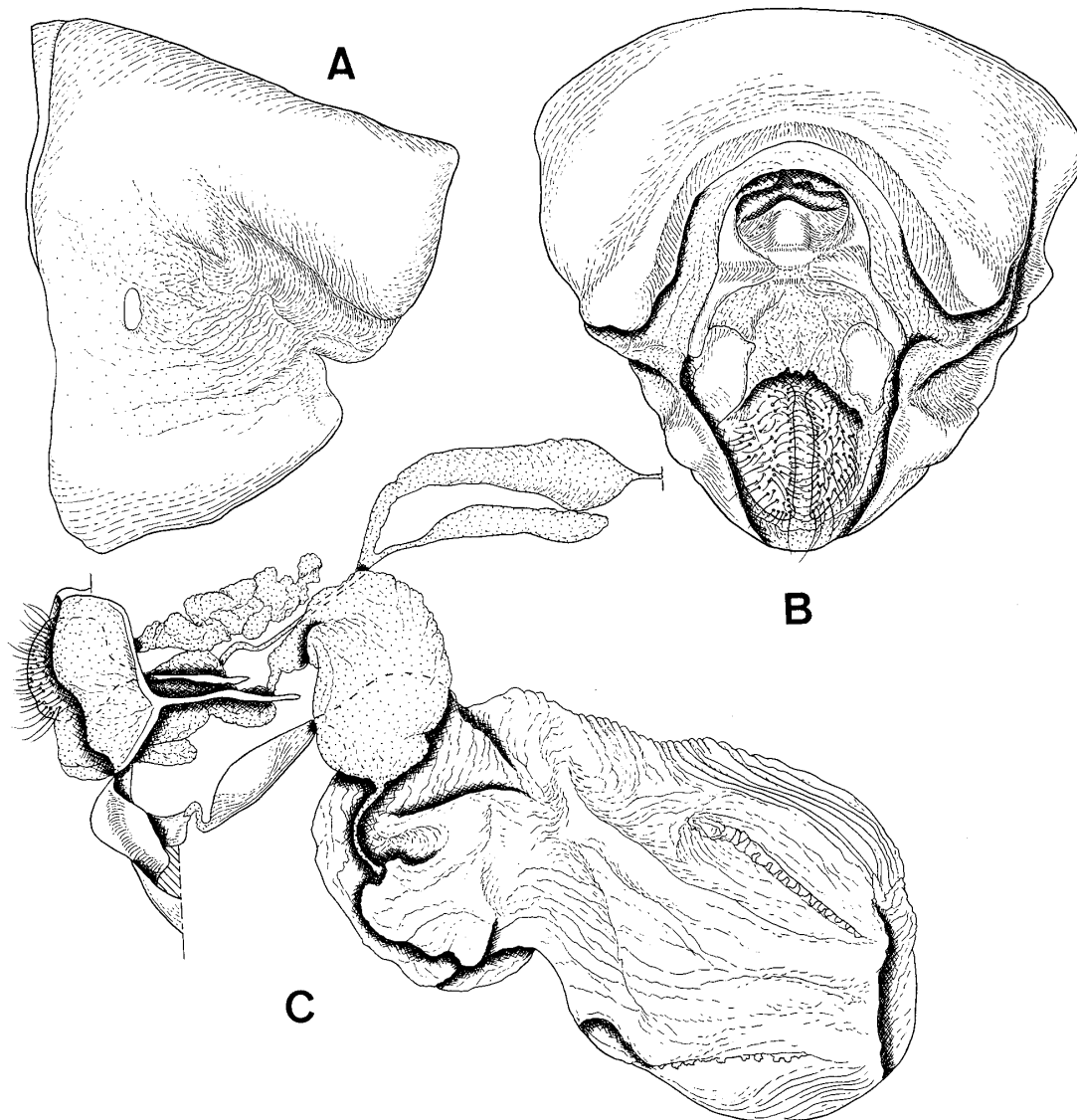


Fig. 20. Female external genitalia and internal reproductive organs of *Callimorpha quadripunctaria* (PODA). A. Seventh abdominal segment in lateral view; B. External genitalia in posteroventral view; C. Internal reproductive organs in lateral view (right).

common stem of 8 and 9. Hind wing with vein 3 from before lower angle of discoidal cell; 4 from lower angle; 5 from above lower angle; 6 and 7 from upper angle or with a short common stem which arises from upper angle.

Wing markings. Upperside of forewing black, with pale yellow oval markings arranged as follows: Four spots on basal 2/3 of costa; two in discoidal cell, apical one yellow; one on base of vein 1; five in space 1, apical one very small; two in space 2, basal one small and apical one large, in *plagiata* apical one very large and to form a wedge-shaped large marking; one large spot in space 3, which is very large and occupies most of space 3 in *plagiata*; one in space 4, but smaller than spot in space 3;

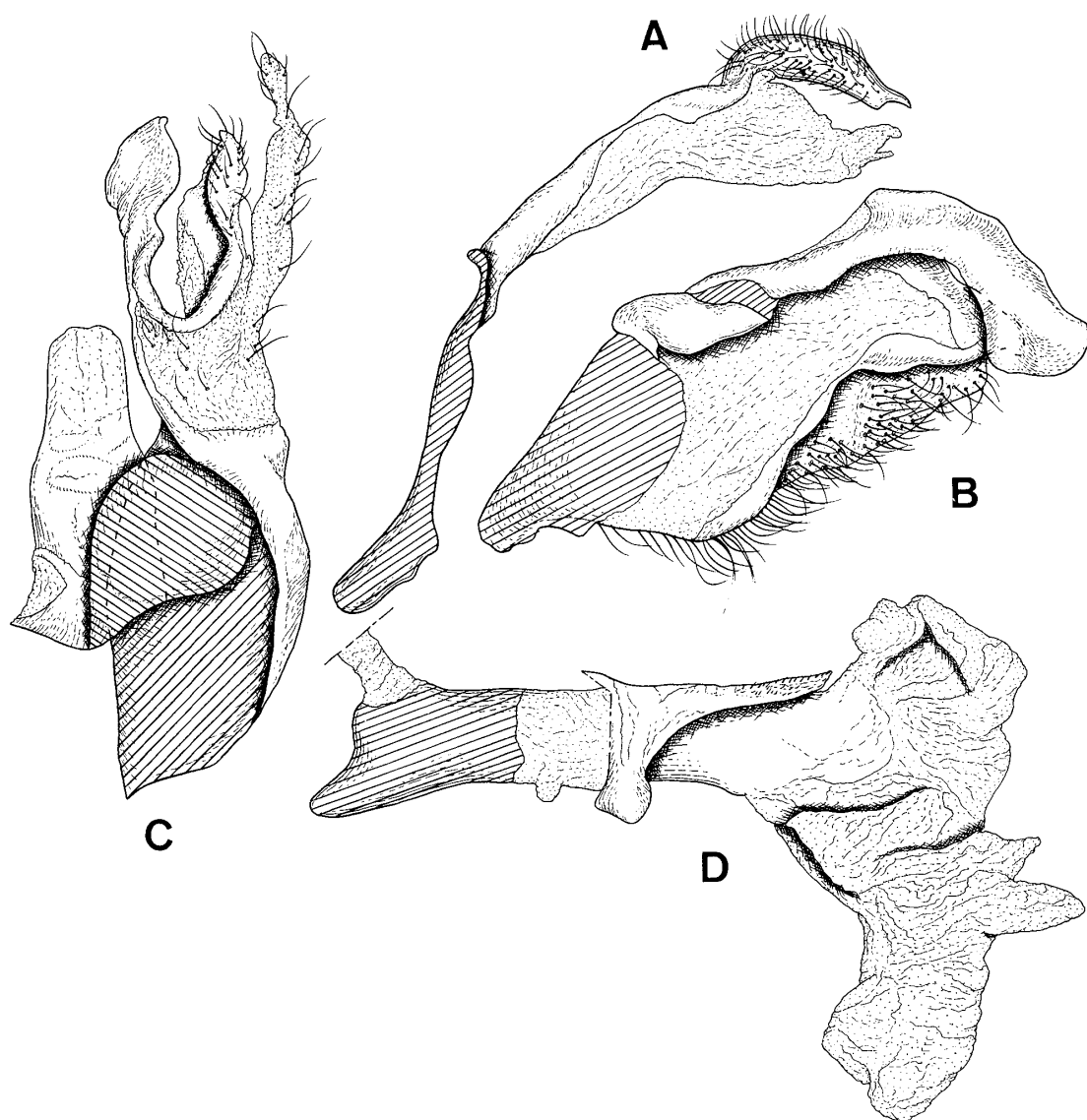


Fig. 21. Male external genitalia of *Aglaomorpha histrio* (WALKER). A. Ring in lateral view; B. Inside of right valva; C. Theca and left valva in dorsal view; D. Phallus and theca in lateral view.

two in space 5, basal one large and apical one small in *histrio*, but in *plagiata* both very large; two in space 6, basal one continuous to basal spot of space 5; one in space 7. Hind wing yellow, with following black markings: Marginal line from vein 8 to 2; submarginal line from subapical portion of vein 8 to space 1, but discontinuous in space 3; one large circular spot on vein 1b; one on apical portion of vein 1a, which is very small in *plagiata*; one large spot on lower angle of discoidal cell; one large spot on upper angle of discoidal cell; one on basal portion of vein 2, which is continuous to basal 1/2 of inner margin to form a black band in *histrio*; each spot on basal 2/3 of inner margin, basal 1/3 of vein 2, and apical 1/3 of vein 1b, that in inner margin small.

Male external genitalia: Tegumen in lateral view long and very narrow (in *histrio*)

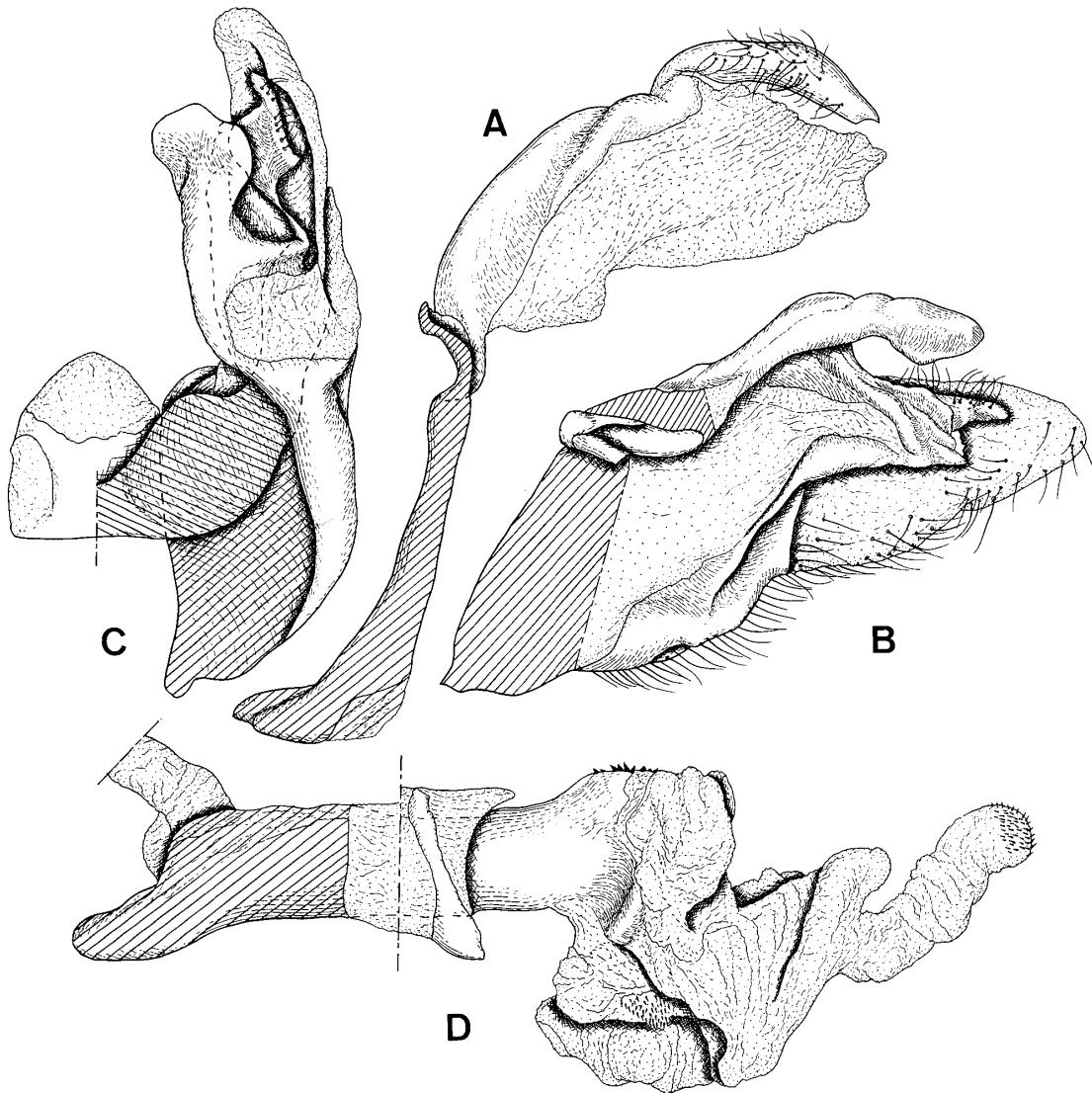


Fig. 22. Male external genitalia of *Aglaomorpha plagiata* (WALKER). A. Ring in lateral view; B. Inside of right valva; C. Theca and left valva in dorsal view; D. Phallus and theca in lateral view.

or rather broad (in *plagiata*), longer than uncus; pedunculus slender and short; acrotergite undeveloped. Fenestrula appearing as a small membranous spot; a pair of narrow lateral membranous slits between tegumen and uncus. Uncus moderately long, slightly tapering posteriorly, gently curving ventrally and sharply pointed at apex, with short hairs. Vinculum long and slender; $2/5 - 1/2$ as deep as ring; saccus rather small, $1/5$ as long as height of ring. Valva large; costa rather wide and long, its dorsal part strongly produced posteriorly to form a long costal process; ampulla rather small, fused with harpe, only weakly produced distally, with its apex not exceeding posteriorly beyond tip of valvula, and clothed with several short hairs on its dorsal portion; anellifer broad, occupying basal $2/3 - 3/4$ of inner wall of valva; harpe much reduced, occupying ventrodistal area of composite ampulla+harpe; sacculus long,

with stiff hairs on its basal $1/2$ of ventral margin; valvula broad, $1/3 - 1/2$ as long as valva, sparsely with stiff hairs; transtillae very wide, expanded and forming a dorsal bridge. Juxta of a weakly sclerotized V-shaped horizontal sclerite, nearly rectangular in lateral view. Theca developed, composed of strongly sclerotized basal portion and membranous or weakly sclerotized apical portion. Phallus thick and straight; supraazonal sheath $2/5 - 1/2$ as long as aedeagus, in *plagiata* the sheath with several small spines on its dorsodistal corner; coecum penis well developed; vesica slightly shorter than aedeagus, everted ventrally (in *histrion*), then directing posteriorly (in *plagiata*), vesica with two groups of minute spinules, each one at subbasal and distal portions, respectively.

Female external genitalia: Seventh abdominal segment uniformly sclerotized except for membranous areas surrounding spiracles. A pair of large tranverse excavations which are presumably clasped by the ampullae of valvae during copulation present along posterior margin of 7th segment. Eighth abdominal segment $2/3$ as high as 7th abdominal segment, 7th tergum completely fused with its sternum which is divided by a broad ventromedian membranous area. Lamella antevaginalis very wide, laterally completely fused with lamella postvaginalis to form a genital cavity, weakly concaved and bulged at middle in ventral view. Ostium bursae large and triangular, wider than long, its sides only strongly raised. Apophysis anterioris slender and rather long, $1/3$ as long as height of 8th abdominal segment. Papilla analis rather small and semicircular, with dense short hairs; apophysis posterioris slender, $2/3$ as long as apophysis anterioris.

Female internal reproductive organs: Bursa copulatrix reaching to posterior $1/2$ of 6th abdominal segment. Ductus bursae rather short, sclerotized and gutter-shaped, directing dorsally or anterodorsally, $1/5 - 1/4$ as long as bursa copulatrix. Cervix bursae well developed and sclerotized, with many complicated furrows on its entire surface. Corpus bursae very large, oval, $2/3 - 3/4$ as long as bursa copulatrix, without signa. Lower part of ductus seminalis + bulla seminalis very large, $1.4\times$ as long as bursa copulatrix, attached to basal portion of right lateral side of cervix bursae, turning to the left below cervix and curved dorsally at $3/5$ of bursa copulatrix, recurved ventrally at the posterior end of cervix bursae, then curved inwardly and continuous to the slender upper part of ductus seminalis. Upper part of ductus seminalis long and slender, extending under ductus bursae, then erected dorsally, and attached to posterior end of dorsal portion of vestibulum. Spermatheca rather small. Glandula seviceae rather short, elliptical, $1/3$ as long as bursa copulatrix. Scent gland rather broad and simple.

This genus is very characteristic in having a well developed costal process and a small process of ampulla of the valva, the well developed basal portion of transtilla of the male genitalia, and a pair of tranverse excavation of the female 7th abdominal segment, lower part of ductus seminalis + bulla seminalis situated on left side of bursa copulatrix of the female internal reproductive organs.

This genus represents the most derived position in the phylogeny of the

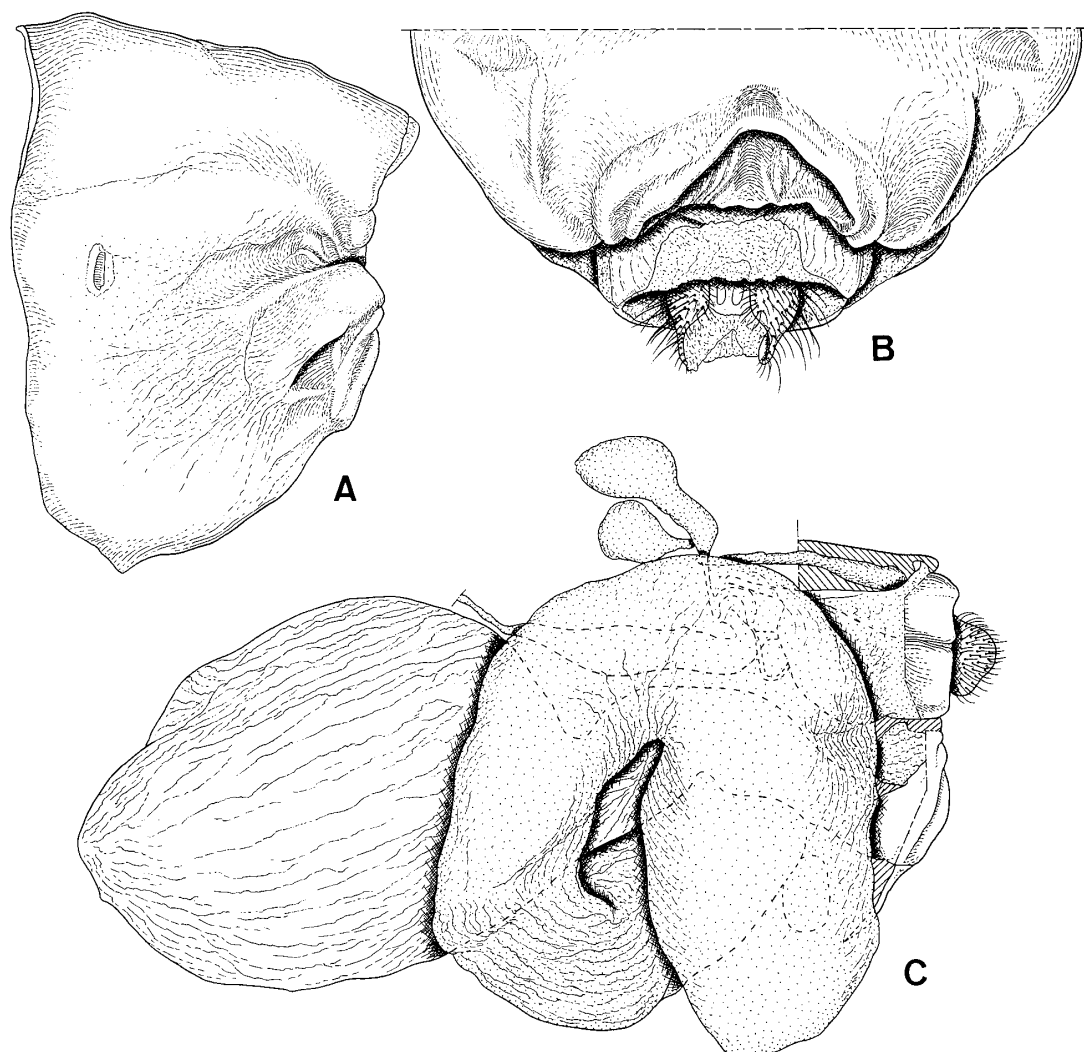


Fig. 23. Female external genitalia and internal reproductive organs of *Aglaomorpha histrio* (WALKER). A. Seventh abdominal segment in lateral view ; B. External genitalia in posteroventral view ; C. Internal reproductive organs in lateral view (left).

Callimorpha genus group. This genus is erected here for the following two species, which have hitherto been included in the genus *Callimorpha*. As stated in the description of the new genus, it is also distinguished external characters from *Callimorpha*, which has smaller patagia, shorter trochanters, distinct areole (vein 10 from before upper angle of discoidal cell and anastomosing with common stem of 7, 8 and 9 to form the areole) of the forewings.

1. *Aglaomorpha histrio* (WALKER, 1855) **comb. nov.** (Figs. 21, 23, 52H, 53A, B)
Hypercompa histrio WALKER, 1855, List Specimen lepid. Insects Colln Br. Mus., 3 : 645.

Distribution : North and Central China, Korea, Taiwan and Japan (Tsushima Is.).

2. *Aglaomorpha plagiata* (WALKER, 1855) **comb. nov.** (Figs. 22, 24, 53C, D)

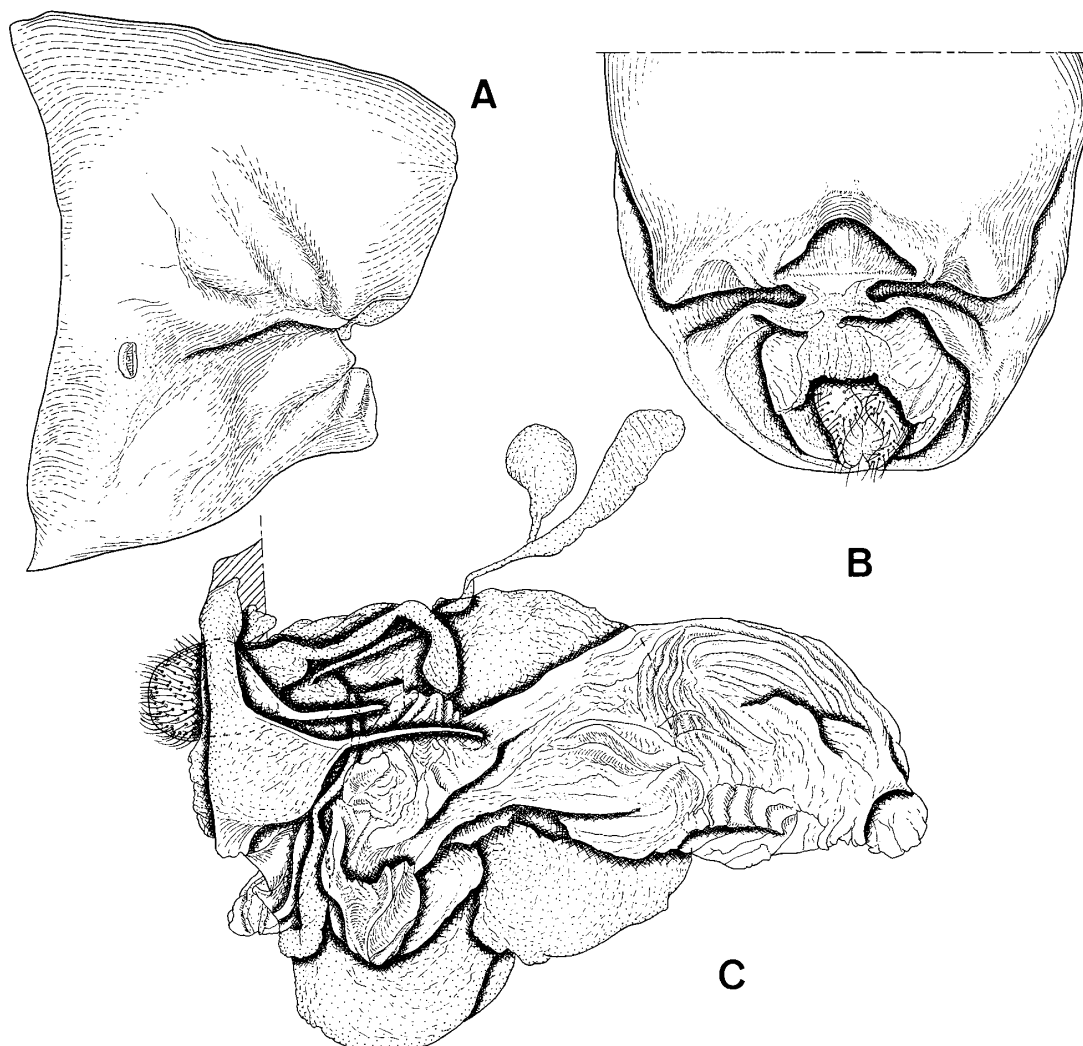


Fig. 24. Female external genitalia of *Aglaomorpha plagiata* (WALKER). A. Seventh abdominal segment in lateral view ; B. External genitalia in posteroventral view ; C. Internal reproductive organs in lateral view (right).

Hypercompa plagiata WALKER, 1855, List Specimen lepid. Insects Colln Br. Mus., 3 : 655.

Distribution : From Kashmir to South China.

4.1.4 The *Arctia* genus group

The *Arctia* genus group is distinctive in having the following autapomorphies : In male genitalia, apical portion of harpe+ampulla of valva strongly elongated distally to form a long process ; in female genitalia, ventromedian portion of 8th abdominal sternum with a small excavation ; lower part of ductus seminalis arising from dorsal portion of right lateral side of cervix bursae.

The *Arctia* genus group contains the following six genera, *Eucharia* HÜBNER,

Hyphoraia HÜBNER, *Parasemia* HÜBNER, *Epicallia* HÜBNER, *Arctia* SCHRANK and *Pericallia* HÜBNER.

4.1.4.1 Genus *Eucharia* HÜBNER, [1820]

Eucharia HÜBNER, [1820], Verz. bekannter Schmett.: 181. Type species: *Phalaena hebe* LINNAEUS, 1767, by subsequent designation by KIRBY, 1880, *Zool. Rec.*, 1878: 197.

P. hebe is a junior subjective synonyms of *Phalaena festiva* HUFNAGEL, 1766, Berl. Mag., 2: 416, 437.

Ammobiota WALLENGREN, 1885, Skand. Heterocer-Fjarilar, 2: 304. Type species: *Phalaena hebe* LINNAEUS, 1767, by monotypy.

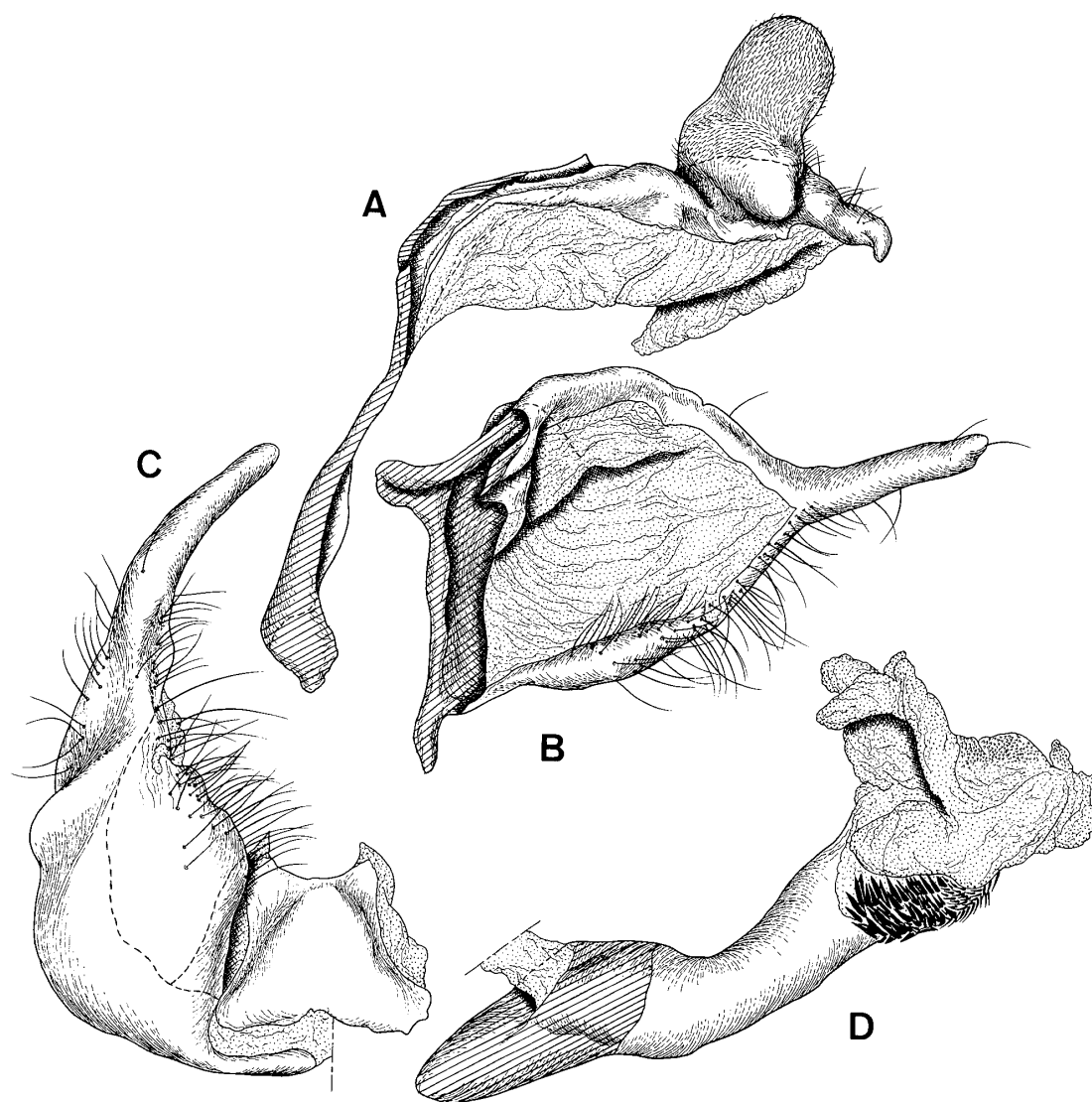


Fig. 25. Male external genitalia of *Eucharia festiva* (HUFNAGEL). A. Ring in lateral view; B. Inside of right valva; C. Left valva and juxta in ventral view; D. Phallus in lateral view.

Male external genitalia: Tegumen in dorsal view triangular, longer than uncus, anterodorsal portion strongly incised so that anterior margin V-shaped, posterior part weakly expanded laterally; in lateral view anterior part of tegumen very narrow; pedunculus very slender; acrotergite weakly developed. Fenestrula appearing as a small spot; membranous slits between tegumen and uncus absent. Uncus in lateral view well developed, bearing basally a pair of large shield-shaped lamellae which are clothed with minute hairs on their entire surfaces except more or less swollen basal portions, apical portion of uncus rather slender and ending in a weakly pointed tip which is curved ventrally, with several short hairs dorsolaterally. Vinculum slender, $3/4$ as deep as ring; saccus undeveloped. Valva large, evenly wide on basal $1/2$, then strongly constricted from basal portion of harpe + ampulla; harpe + ampulla produced distally into a long horn-like process; costa long and narrow; anellifer broad and occupying basal $1/2$ of inner wall of valva; sacculus long and narrow, with sparse and long hairs; labides absent. Juxta trapezoidal, distal margin weakly emarginate. Phallus modelately long; suprazonal sheath weakly curved dorsally at basal $1/3$, densely bearing short spines on its lateral perivesical area; coecum penis developed and produced anteroventrally; vesica everted dorsally and posteriorly, $1/3$ as long as aedeagus, and with dense short spinules on posterior $1/2$ of its dorsal surface.

In this genus the basal portion of male uncus has a pair of shield-shaped lamellae and the left side of perivesical area of aedeagus is provided with many distinct spines. These are autoapomorphies of this genus. Although the male genitalia of this genus lack the labides which are only one synapomorphic character of the male genitalia of five other genera of the *Arctia* genus group, the other genital structures are similar to those of the other genera.

I examined the male genitalia of the following species.

1. *Eucharia festiva* (HUFNAGEL, 1766) (Figs. 25, 53G)
Phalaena festiva HUFNAGEL, 1766, Berl. Mag., 2: 416, 437.
 Distribution: Central Europe to eastern Asia.

4.1.4.2 Genus *Hyphoraia* HÜBNER, [1820]

Hyphoraia HÜBNER, [1820], Verz. bekannter Schmett.: 182. Type species: *Phalaena aulica* LINNAEUS, 1758, by subsequent designation by KIRBY, 1892, Synonymic Cat. Lepid. Heterocera, 1: 261.

Male external genitalia: Dorsum much elongated, longer than height of ring, in dorsal view triangular, evenly tapering to the middle of uncus. Tegumen long and large, broad at base, narrowed posteriorly; in lateral view slender, $1/2$ as high as ring; pedunculus short and narrow; acrotergite weakly developed. Fenestrula rather broad; membranous slits between tegumen and uncus absent. Uncus extremely long, in dorsal view wide and weakly narrowed posteriorly on basal $1/2$, evenly slender on apical $1/2$; in lateral view long and slender, basal $1/2$ gently curved dorsally, then weakly curved ventrally and tapered towards weakly pointed tip, with some short hairs on its dorsal surface. Vinculum long, $2/3$ as deep as ring; saccus undeveloped.

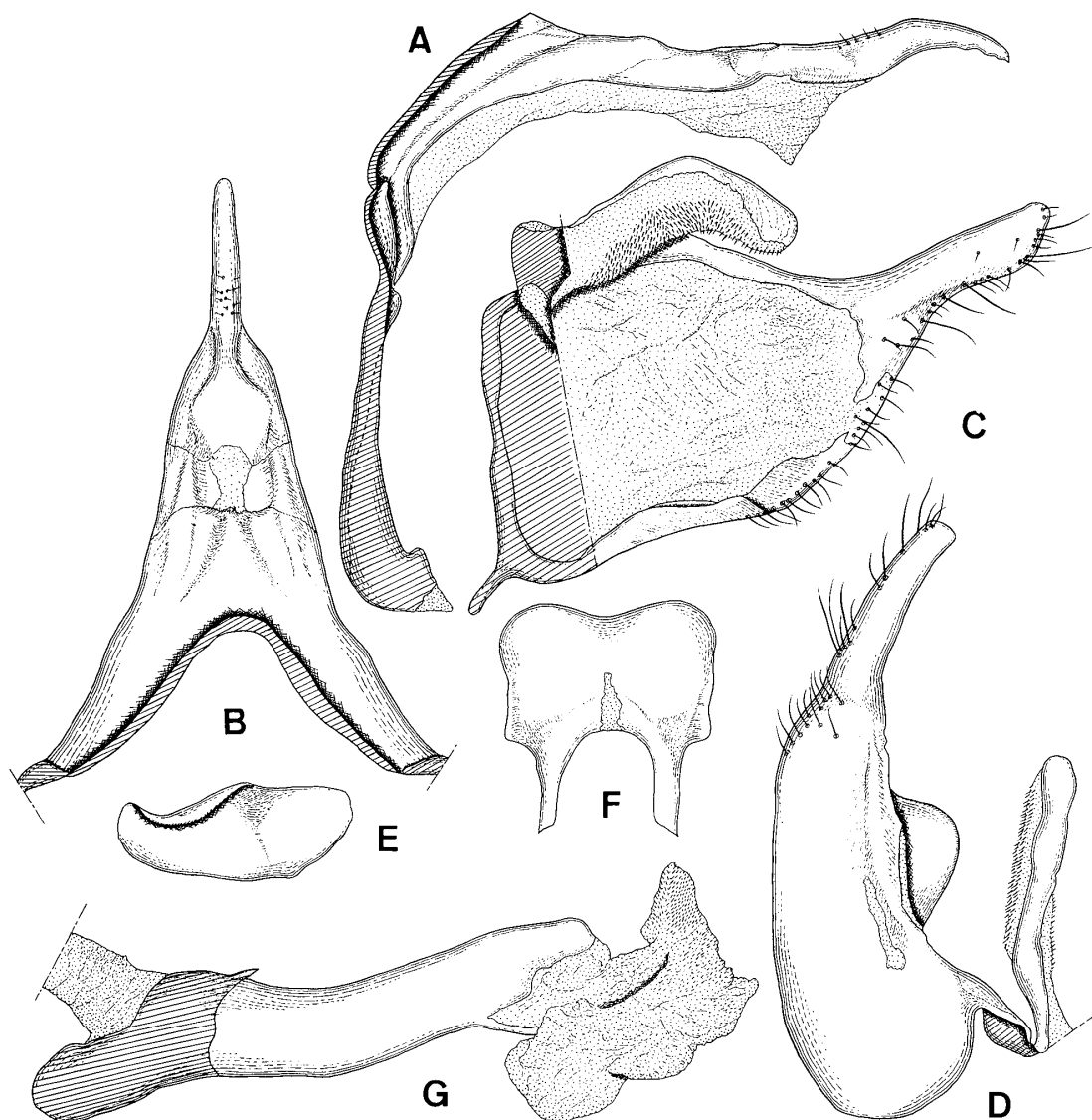


Fig. 26. Male external genitalia of *Hyphoraia aulica* (LINNAEUS). A. Ring in lateral view; B. Dorsum in dorsal view; C. Inside of right valva; D. *Ditto* in dorsal view; E. Juxta in lateral view; F. *Ditto* in ventral view; G. Phallus in lateral view.

Valva large, broad basally, much narrowed beyond basal 1/3 towards evenly slender apical 1/3 which is weakly curved inwardly; costa long and narrow, continuous to dorsoproximal portion of harpe+ampulla, without membranous incision; harpe+ampulla produced distally into a long lamellate process; anellifer broad and occupying 2/3 of inner wall of valva; sacculus long and narrow; labides well developed, extending posteriorly beyond the middle of valva, weakly sclerotized dorsally, membranous ventrally and bearing many short spinules on ventral surface. Juxta almost rectangular, with strongly emerginated distal margin in ventral view. Phallus moderately long and rather slender; suprazonal sheath weakly curved dorsally, without carina penis; subzonal sheath 1/3 as long as aedeagus; coecum penis moderately long; left

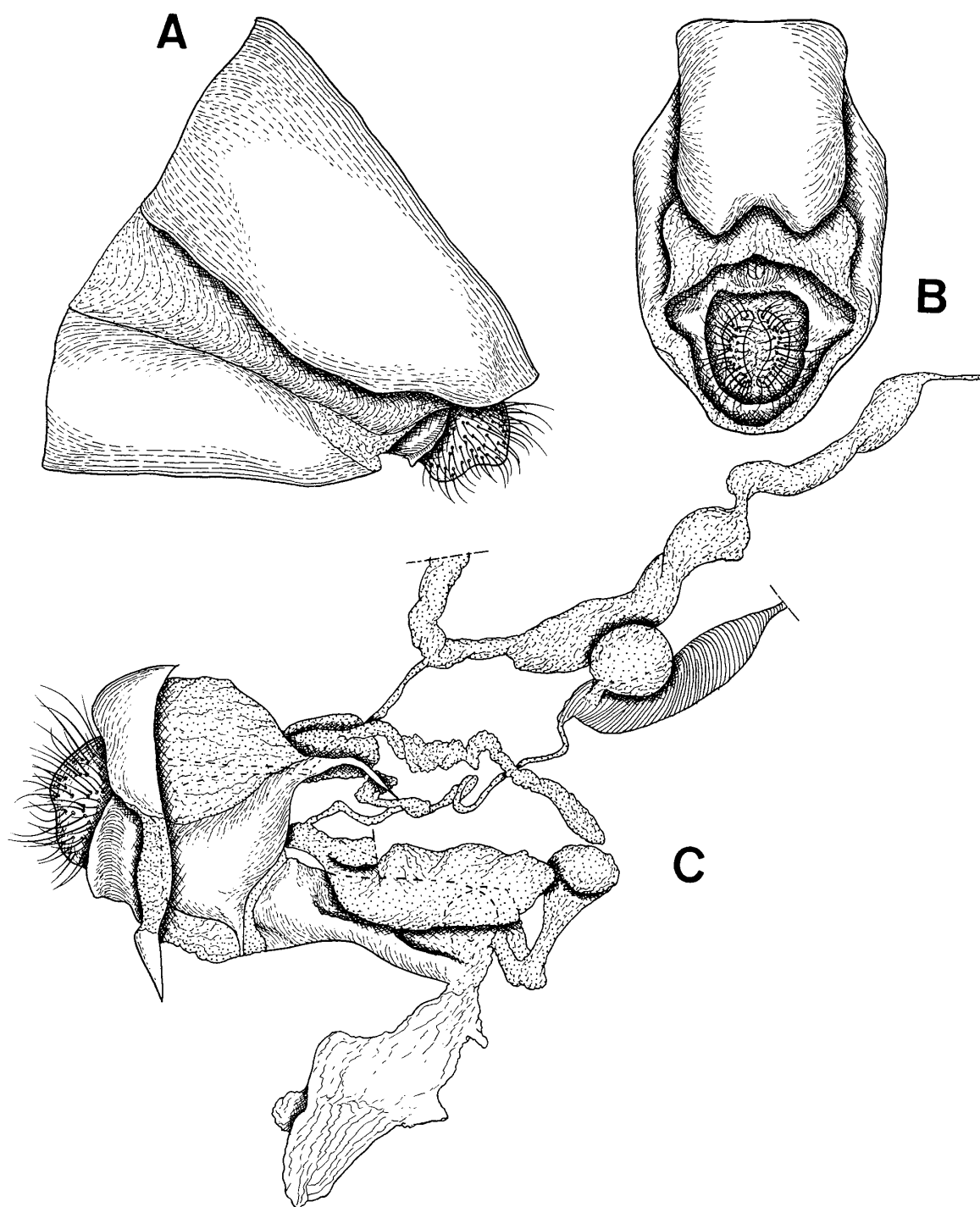


Fig. 27. Female external genitalia and internal reproductive organs of *Hyphoraia aulica* (LINNAEUS). A. External genitalia in lateral view ; B. *Ditto* in ventral view ; C. Internal reproductive organs in lateral view (right).

perivesical area weakly developed without spinules ; vesica everted posteriorly, 1/3 as long as aedeagus, with minute spinules on its dorsal surface.

Female external genitalia : Seventh abdominal segment directing posteroventrally.

Seventh abdominal tergum and sternum large. Eighth abdominal segment $1/4$ as high as 7th segment, uniformly sclerotized; a small deep excavation, which is presumably hooked by uncal tip of the male genitalia during copulation, present on middle portion of 8th abdominal sternum. Lamella antevaginalis completely fused with lamella postvaginalis. Ostium bursae crescent in shape. Apophysis anterioris rather short and weakly curved ventrally, $2/5$ as long as height of 8th segment. Papilla analis in lateral view moderate in size, nearly triangular, with sparse short hairs; apophysis posterioris is nearly straight, slightly longer than apophysis anterioris.

Female internal reproductive organs: Bursa copulatrix reaching to posterior $1/4$ of 6th abdominal segment. Antrum broad, its ventral portion membranous. A narrow membranous slit present between antrum and ductus bursae. Ductus bursae moderately long, nearly straight, well sclerotized and gutter-shaped, $2/5$ as long as bursa copulatrix. Cervix bursae not much developed and membranous. Corpus bursae moderately large and globular, membranous, $1/2$ as long as bursa copulatrix; signa represented by a pair of small patches which bear several small spinules. Lower part of ductus seminalis+bulla seminalis rather small, $1/2$ as long as corpus bursae, attached to dorsal portion of cervix bursae; upper part of ductus seminalis broad, attached to ventral portion of vestibulum. Spermatheca nearly elliptical. Glandula sevacea very long, subequal in length to bursa copulatrix. Scent gland very long and simple.

This genus is characteristic in having the elongated dorsum of male genitalia and the female 7th abdominal segment directing posteroventrally.

I examined the genitalia of the following species.

1. *Hyphoraia aulica* (LINNAEUS, 1758) (Figs. 26, 27, 53E, F)

Phalaena aulica LINNAEUS, 1758, Syst. Nat. (Edn 10), 1: 505.

Distribution: From Central Europe to Japan (Hokkaido) through northern Asia and Amur.

4.1.4.3 Genus *Parasemia* HÜBNER, [1820]

Parasemia HÜBNER, [1820], Verz. bekannter Schmett.: 181. Type species: *Phalaena plantaginis* LINNAEUS, 1758, by subsequent designation by KIRBY, 1892 Synonymic Cat. Lepid. Heterocera, 1: 250.

Nemeophila STEPHENS, 1828, Illust. Br. Ent. (Haustellate), 2: 55, 72. Type species: *Phalaena plantaginis* LINNAEUS, 1758, by monotypy.

Chionophila GUENÉE, 1865, *Annls Soc. ent. Fr.*, (4) 4: 686. Type species: *Phalaena plantaginis* LINNAEUS, 1758, by subsequent designation by WATSON, 1980, The Generic Names of Moths of the World, 2: 143.

Eupsychoma GROTE, 1865, *Proc. ent. Soc. Philad.*, 4: 417. Type species: *Eupsychoma geometrica* GROTE, 1865, by monotypy.

E. geometrica is a junior subjective synonym of *Phalaena plantaginis* LINNAEUS, 1758.

Male external genitalia: Dorsum moderately long, nearly triangular, and weakly expanded laterally at the level of fenestrula in dorsal view. Tegumen in dorsal view longer than uncus, narrowed posteriorly, separated into anterior and posterior parts;

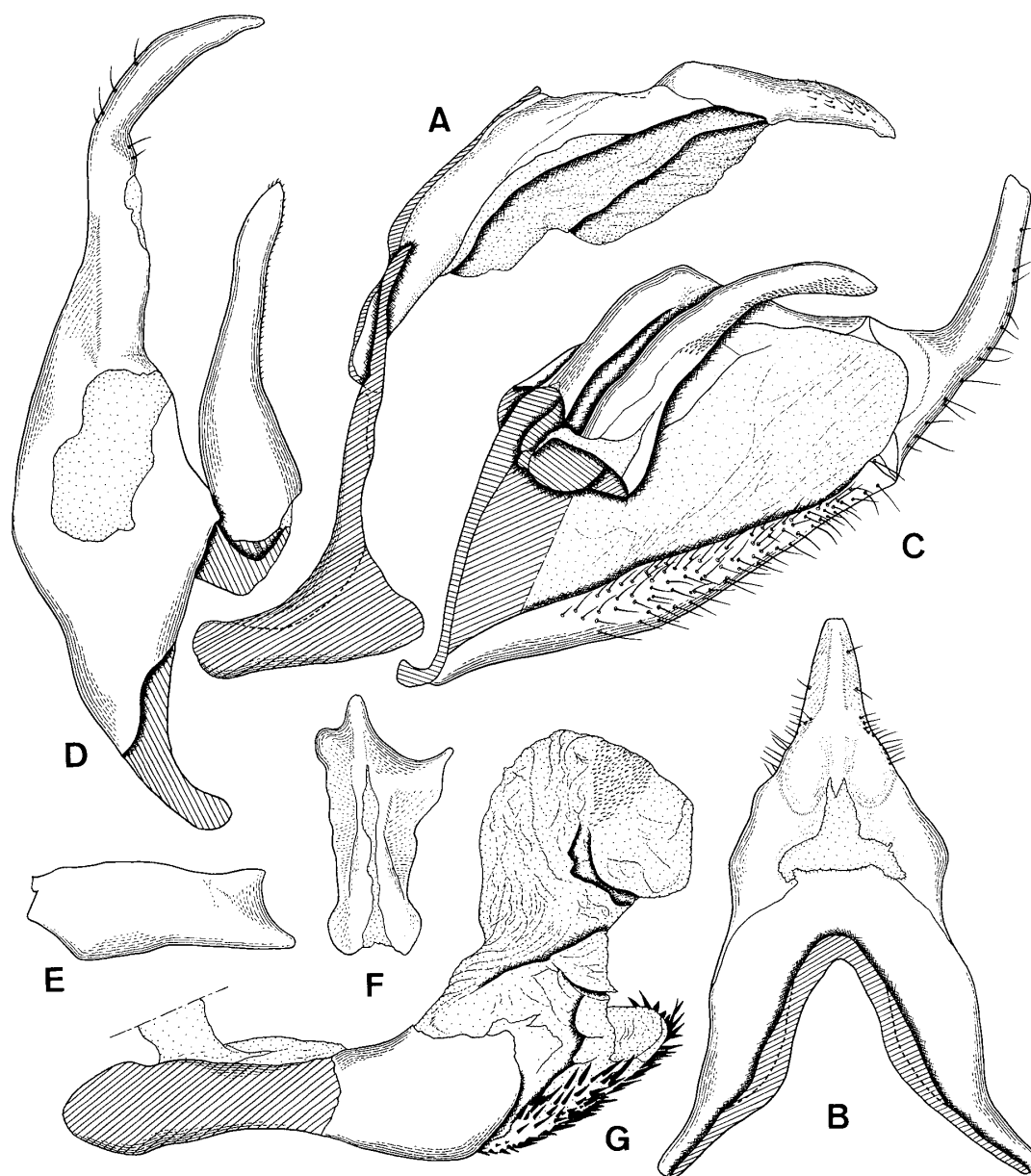


Fig. 28. Male external genitalia of *Parasemia plantaginis* (LINNAEUS). A. Ring in lateral view ; B. Dorsum in dorsal view ; C. Inside of right valva ; D. *Ditto* in dorsal view ; E. Juxta in lateral view ; F. *Ditto* in ventral view ; G. Phallus in lateral view.

in lateral view long and slender ; pedunculus rather long ; acrotergite weakly developed. Fenestrula rather broad ; membranous slits between tegumen and uncus absent. Uncus in dorsal view broad, weakly swollen at base and tapering to apex, with several short hairs laterally ; in lateral view nearly straight and narrowed towards tip which is weakly pointed. Vinculum long and slender, $\frac{3}{4}$ as deep as ring ; saccus well developed, $\frac{2}{5}$ as long as height of ring. Valva large and broad, gradually narrowed apically to basal portion of harpe+ampulla ; costa narrow and long, separated from

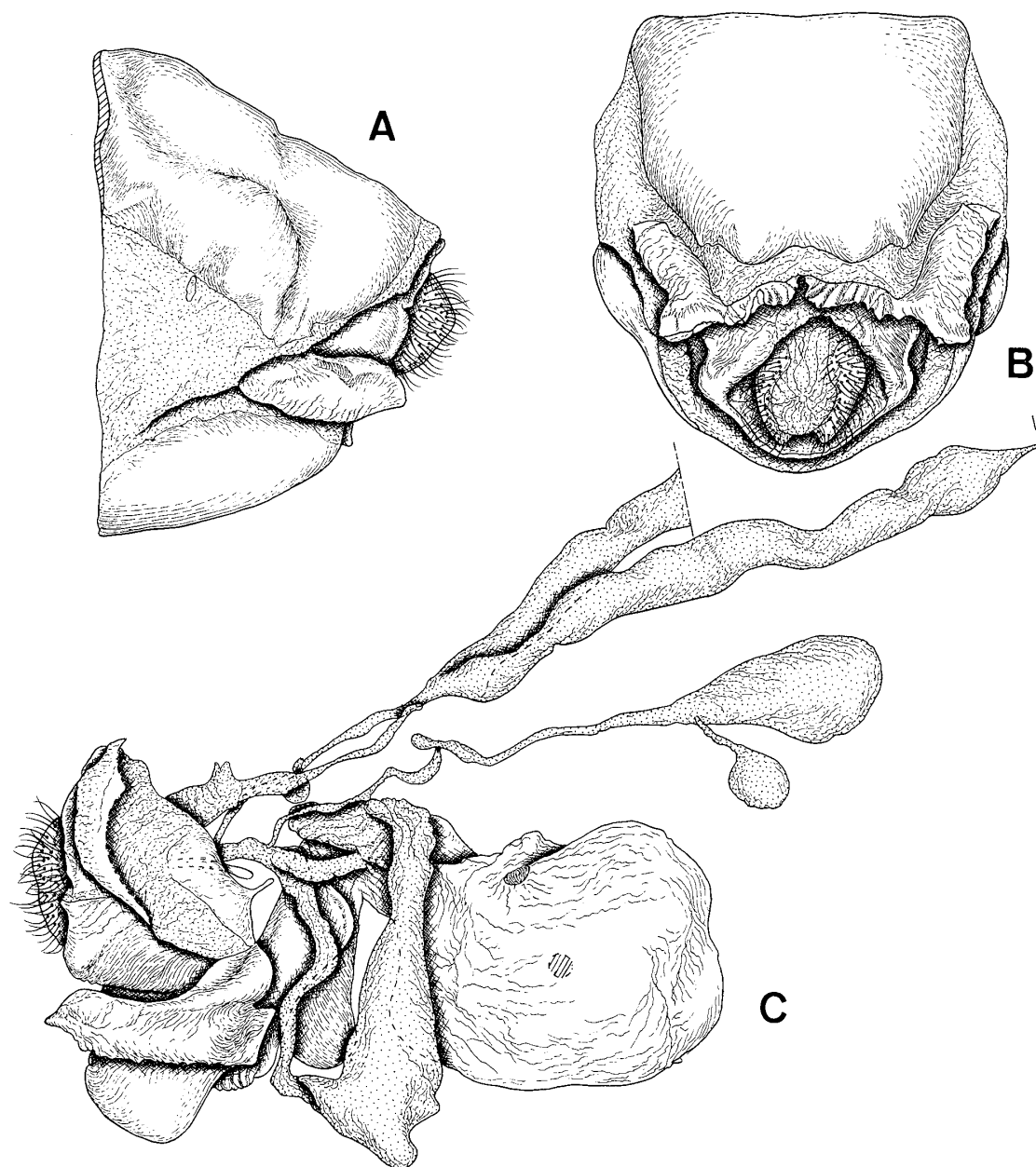


Fig. 29. Female external genitalia and internal reproductive organs of *Parasmia plantaginis* (LINNAEUS). A. External genitalia in lateral view; B. *Ditto* in posteroventral view; C. Internal reproductive organs in lateral view (right).

dorsoproximal portion of harpe+ampulla by a weakly sclerotized incision from anellifer; harpe+ampulla produced to form a long process; anellifer broad and occupying basal 3/4 of inner wall of valva; sacculus long and narrow, separated from ventroproximal portion of harpe+ampulla by a weakly sclerotized incision from anellifer, with many short hairs on its posterior 2/3; transtilla fused with base of labides; labides well developed, 1/2 as long as valva, produced distally into a horn-like process, with many short spinules ventral on its distal 1/2. Juxta rather narrow, asymmetrical, and with a membranous slit on basal 3/4 left side more strongly widened

and emerginated posteriorly than right side. Phallus thick, rather short and straight ; suprazonal sheath thickened distally ; ventral portion of lateral perivesical area bearing many distinct short spines ; subzonal sheath $1/2$ as long as aedeagus ; vesica $1/2$ as long as aedeagus, everted dorsally, with cornutus which is represented by minute spinules on dorsal portion of posterior $1/2$ of vesica.

Female external genitalia : Seventh abdominal tergum and sternum large. A pair of large sclerites, which are presumably clasped by processes of harpe+ampulla of male valvae during copulation, developed along posterior margin of ventral area of 7th abdominal segment ; the sclerite more or less serrate, and continuous to lamella antevaginalis. Eighth abdominal segment $1/3$ as high as 7th abdominal segment, uniformly sclerotized, without ventral membranous area ; a small deep excavation, which is presumably hooked by uncal tip of the male genitalia during copulation, present on median portion of 8th sternum. Lamella antevaginalis completely united with lamella postvaginalis. Ostium bursae oval. Apophysis anterioris very short and slender, $1/10$ as long as height of 8th segment. Papilla analis moderate in size, triangular in lateral view, with dense short hairs ; apophysis posterioris rather long, $3\times$ as long as apophysis anterioris.

Female internal reproductive organs : Bursa copulatrix reaching to posterior $1/2$ of 6th segment. Antrum broad and short. Membranous area between antrum and ductus bursae absent. Ductus bursae moderately long, $1/5$ as long as bursa copulatrix, directing anterodorsally, sclerotized and its ventral surface strongly concaved. Cervix bursae rather small and weakly sclerotized. Corpus bursae moderately large and globular, membranous, $1/2$ as long as bursa copulatrix ; signa represented by three circular plates bearing some small spinules. Lower part of ductus seminalis+bullae seminalis gradually bulged ventrally, subequal in length to corpus bursae, attached to posterior $1/2$ of right lateral side of cervix bursae and extending ventrally ; upper part of ductus seminalis long and slender, erected dorsally, attached to left lateral side of vestibulum. Spermatheca rather small and rounded. Glandula seviceae very long, $1.4\times$ as long as bursa copulatrix. Scent gland rather short and simple.

This genus is characteristic in having the following autapomorphies : Many distinct short spines on ventral portion of lateral perivesical area, vesica everted dorsally and asymmetrical juxta in the male, ductus bursae directed anterodorsally in the female genitalia.

This genus includes only one species, *plantaginis*, in the world.

1. *Parasemia plantaginis* (LINNAEUS, 1758) (Figs. 28, 29, 53H, 54A)

Phalaena plantaginis LINNAEUS, 1758, Syst. Nat. (Edn 10), 1 : 501.

Distribution : From W. Europe across Russia and Asia to Japan (Hokkaido and northern Honshu), also in N. America.

4.1.4.4 Genus *Arctia* SCHRANK, 1802

Arctia SCHRANK, 1802, Fauna Boica, 2 (2) : 152. Type species : *Phalaena caja* Linnaeus 1758, by subsequent designation by WESTWOOD, 1840, Introd. mod. Classif. Insects, 2 : 92.

- Eyprepia* OCHSENHEIMER, 1810, Schmett. Eur. **3** : 299. Type species : *Phalaena caja* LINNAEUS, 1758, by subsequent designation by CURTIS, 1824, Br. Ent., **1** : 21.
- Zoote* HÜBNER, [1820], Verz. bekannter Schmett. : 191. Type species : *Phalaena caja* LINNAEUS, 1758, by subsequent designation by HAMPSON, 1901, Cat. Lepid. Phalaenae Br. Mus., **3** : 463.
- Chelonia* GODART, [1823], Hist. nat. Lepid. Papillons Fr., **4** : 299. Type species : *Phalaena caja* LINNAEUS, 1758, by subsequent designation by DUPONCHEL, 1843, Dict. univ. Hist. nat., **3** : 460. A junior homonym of *Chelonia* BRONGNIART, 1800, Bull. Soc. philomath. Paris **2*** 89, -Reptilia.
- Callarctia* PACKARD, 1864, Proc. ent. Soc. Philad., **3** : 114. Type species : *Phalaena caja* LINNAEUS, 1758, by subsequent designation (for *Chelonia* GODART, [1823]) by DUPONCHEL, 1843, Dict. univ. Hist. nat., **3** : 460.

Male external genitalia : Dorsum triangular in dorsal view, evenly tapering to the middle portion of uncus. Tegumen longer than uncus, in dorsal view broad at base, narrowed posteriorly, anterodorsal portion strongly incised ; in lateral view narrow and subequal in height to vinculum ; pedunculus rather long and narrow ; acrotergite weakly developed. Fenestrula appearing as a small triangular area ; membranous slits between tegumen and uncus absent. Uncus in dorsal view broadly rounded at base and gradually tapering to apex, with several short hairs laterally ; in lateral view nearly straight and tapered towards weakly pointed tip. Vinculum very narrow, $3/5$ as deep as ring ; saccus large, $1/2$ as long as height of ring. Valva very large, almost rhombic ; costa rather wide and long, fused with harpe + ampulla ; harpe + ampulla produced to form a rather short process ; anellifer broad and occupying most part of inner wall of valva ; sacculus long and narrow, separated from ventroproximal portion of harpe + ampulla by a weakly sclerotized incision from anellifer ; transtilla very long ; labides $1/3$ as long as valva, well sclerotized except for basal $1/3$, entirely bare. Juxta almost oval with membranous area medially. Phallus rather short and moderately thick ; suprazonal sheath strongly curved dorsally at basal $1/3$, without perivesical area ; subzonal sheath $1/3$ as long as aedeagus ; vesica large, $2/3$ as long as aedeagus, everted dorsally, bearing minute spinules on its entire surface.

Female external genitalia : Seventh abdominal tergum well sclerotized and indistinctly separated from 7th sternum ; 7th abdominal sternum well sclerotized and large, more or less excavated laterally beyond the middle, and with a deep ventromedian longitudinal groove which is presumably hooked by labides of male valvae during copulation ; anterior $1/2$ of the sternum with several longitudinal wrinkles laterally, posterior $1/2$ of the sternum produced posterolaterally into a complicated projection which is presumably clasped by process of harpe + ampulla of male valva. Eighth abdominal segment $1/4$ as high as 7th abdominal segment ; a large and deep excavation, which is hooked by uncus tip of male genitalia during copulation, present on the middle portion of 8th sternum ; apophysis anterioris short, directing anterodorsally $1/15$ as long as height of 8th segment. Copulatory cavity well sclerotized. Ostium bursae oval. Papilla analis in lateral view small, triangular, with dense short hairs ; apophysis posterioris short, $1.5\times$ as long as apophysis anterioris.

Female internal reproductive organs : Bursa copulatrix reaching to posterior $1/3$ of 6th abdominal segment. Antrum rather broad ; narrow membranous slit present between antrum and ductus bursae. Ductus bursae long, $1/3$ as long as bursa

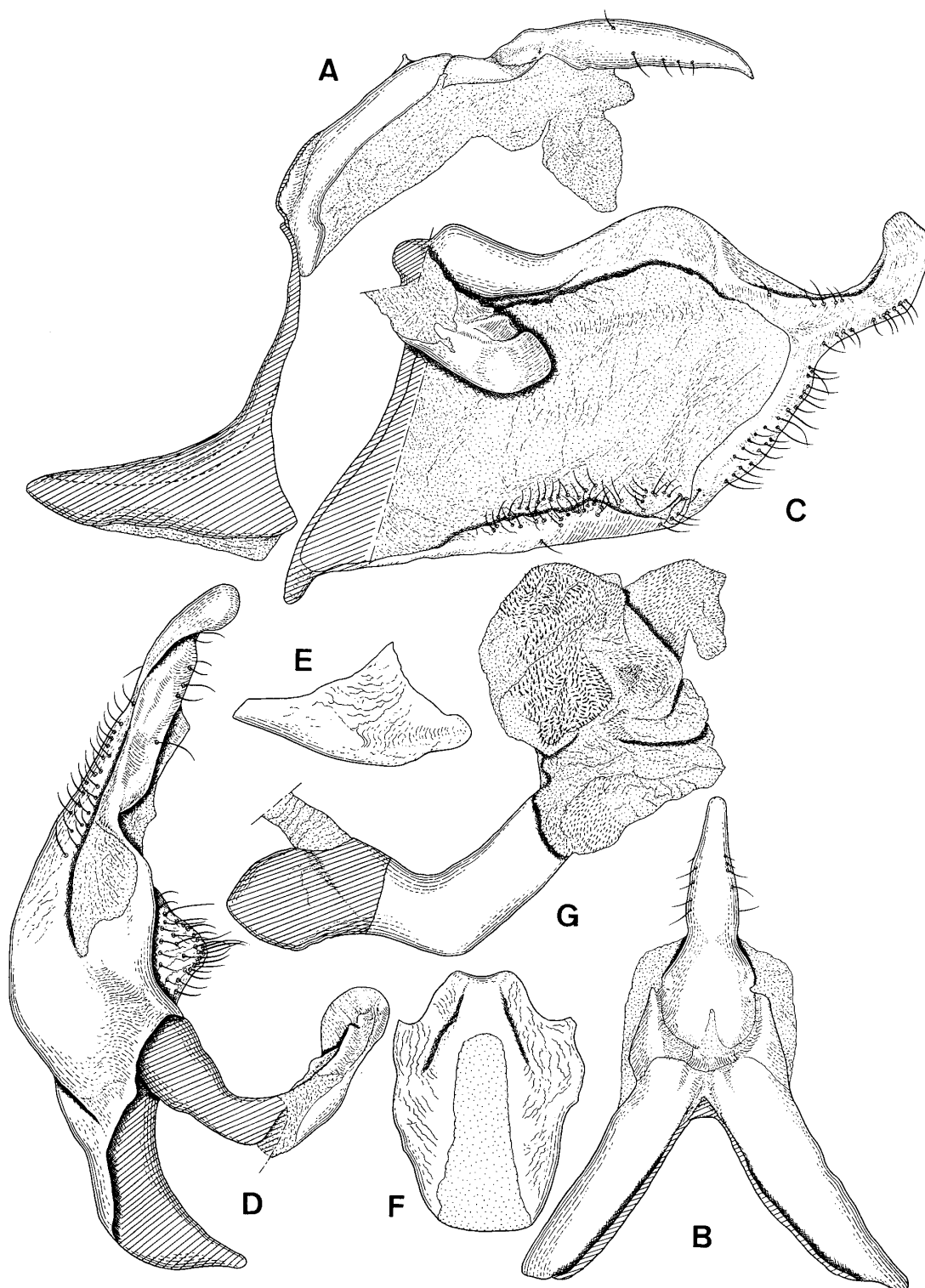


Fig. 30. Male external genitalia of *Arctia caja* (LINNAEUS). A. Ring in lateral view ; B. Dorsum in dorsal view ; C. Inside of right valva ; D. *Ditto* in dorsal view ; E. Juxta in lateral view ; F. *Ditto* in ventral view ; G. Phallus in lateral view.

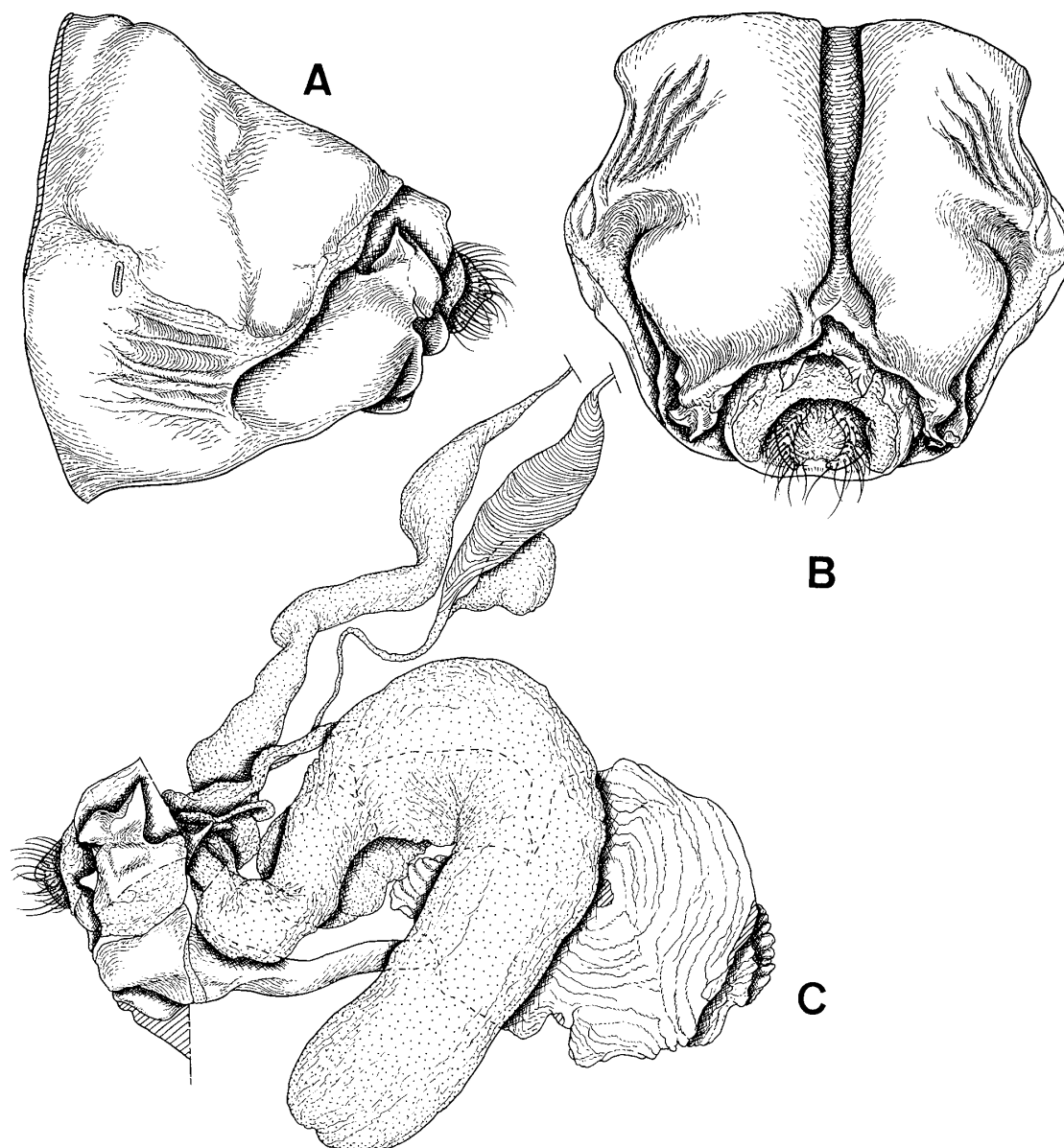


Fig. 31. Female external genitalia and internal reproductive organs of *Arctia caja* (LINNAEUS). A. External genitalia in lateral view; B. *Ditto* in ventral view; C. Internal reproductive organs in lateral view.

copulatrix, nearly straight and directed anteriorly; ductus bursae sclerotized and its dorsal surface strongly concaved. Cervix bursae rather large and well sclerotized, with many complicated furrows on its entire surface. Corpus bursae in lateral view large and globular, $2/5$ as long as bursa copulatrix, bearing concentric circular wrinkles surrounding signum; signa represented by a pair of circular plates bearing some small spinules. Lower part of ductus seminalis thick, arising from dorsal $1/2$ of cervix bursae and extending posteriorly, attached to posterior $1/3$ of left lateral side of bulla seminalis; bulla seminalis very large, subequal in length to bursa copulatrix, curved posteroventrally at level of base of cervix bursae and extending to ventrally

beyond posterior $1/3$ of ductus bursae ; upper part of ductus seminalis short and thick, attached to left lateral side of vestibulum. Spermatheca fusiform. Glandula sevacea moderately long, subequal in length to bursa copulatrix. Scent gland moderately long and simple.

This genus is very characteristic in having the following apomorphic characters : Well developed coecum penis of aedeagus, suprazonal sheath of aedeagus strongly curved posterodorsally, female 7th abdominal segment uniformly sclerotized leaving indistinct lateral membranous areas, and its sternum with a deep median longitudinal groove.

I examined the genitalia of the following species.

1. *Arctia caja* (LINNAEUS, 1758) (Figs. 30, 31, 54C, D)
Phalaena caja LINNAEUS, 1758, Syst. Nat. (Edn 10), 1 : 500.
 Distribution : Holarctic Region including Japan (Hokkaido and Honshu).
2. *Arctia fasciata* (ESPER, 1784) (Fig. 54B)
 (The male genitalia not examined.)
Bombyx fasciata ESPER, 1784, Schmett., 3 : 178.
 Distribution : South France, Western North Italy, Spain and North Africa.

4.1.4.5 Genus *Epicallia* HÜBNER, [1820]

Epicallia HÜBNER, [1820], Verz. bekannter Schmett. : 182. Type species : *Phalaena villica* LINNAEUS, 1758, by monotypy.

Male external genitalia : Dorsum gradually tapering posteriorly. Tegumen in dorsal view as long as uncus, anterodorsal portion strongly incised ; in lateral view rather slender, $2/5$ as high as ring ; pedunculus short and rather thick ; acrotergite weakly developed. Fenestrula appearing as a small spot ; membranous slits between tegumen and uncus absent. Uncus rather long, in lateral view gradually thickened to posterior $1/5$, then strongly tapered and ending in an acute tip, short haired on basal $2/3$. Vinculum slender dorsally, widened ventrally, $2/3$ as deep as ring ; saccus undeveloped. Valva large, almost quadrate on basal $1/2$, projected into a long horn-like process on apical $1/2$; costa long and rather broad, proximally bearing a small protuberance just lateral to labides ; harpe+ampulla produced distally into a long straight process ; anellifer broad and occupying inner wall of basal $1/2$ of valva ; sacculus long and narrow, sparsely short-haired ; labides well developed, $1/3$ as long as valva, covered with many minute spinules almost on its entire surface. Juxta almost rectangular. Phallus moderately long and rather thick ; suprazonal sheath strongly curved dorsally at basal $1/3$, without carina penis ; subzonal sheath $1/5$ as long as aedeagus ; coecum penis well developed, protruding ventrally ; vesica everted dorsally, $1/2$ as long as aedeagus, with a rectangular plate and two congregations of small spines.

Female external genitalia : Seventh abdominal tergum very large and well sclerotized ; 7th sternum absent and broad membranous area occupying ventral region of this

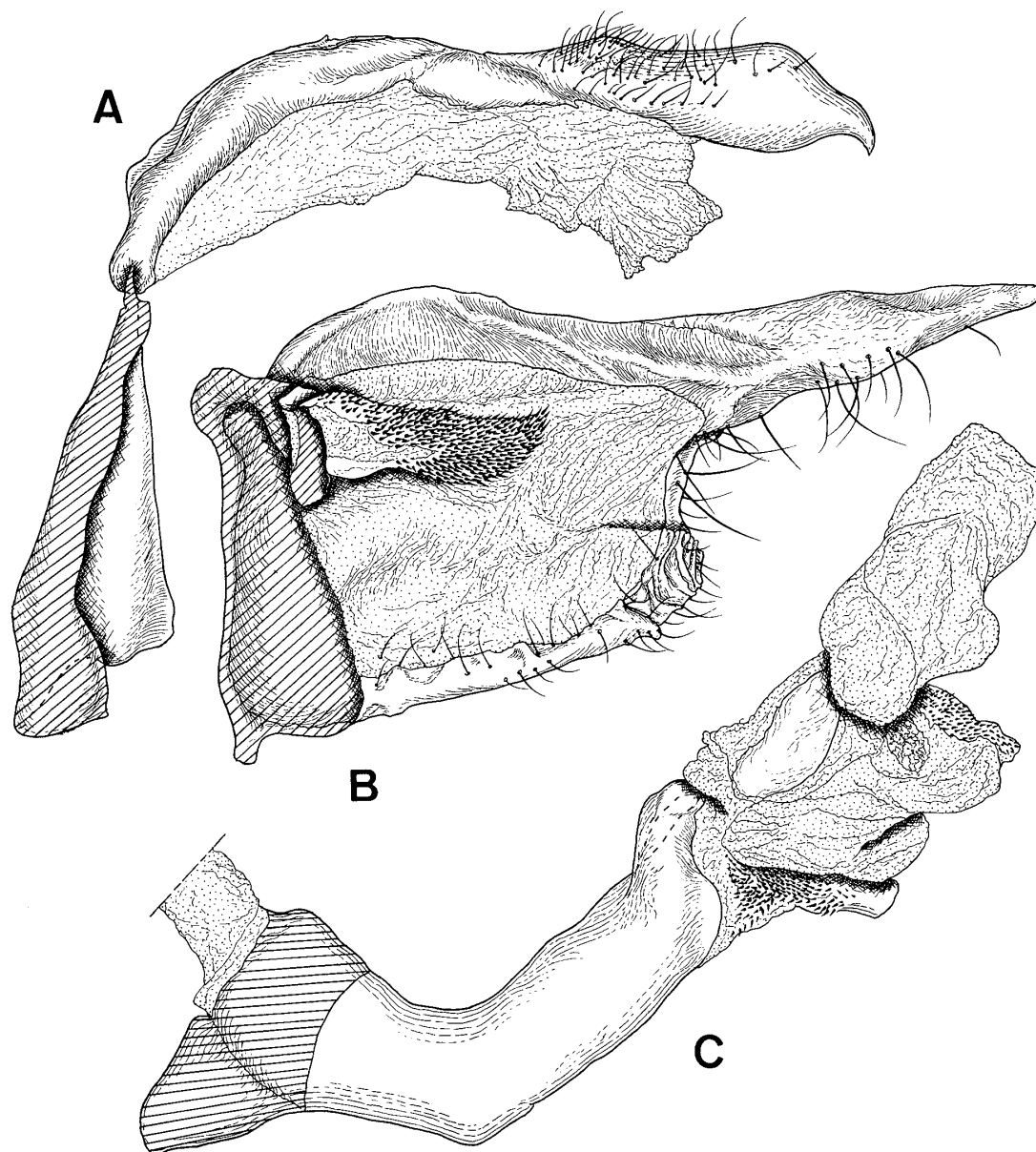


Fig. 32. Male external genitalia of *Epicallia villica* (LINNAEUS). A. Ring in lateral view ;
B. Inside of right valva ; C. Phallus in lateral view.

segment ; a pair of concaved areas, which are clasped by labides of valvae during copulation, present on posterolateral portions of ventral membranous area. Crescent-shaped secondary sclerite, which is presumably clasped by processes of harpe + ampulla regions of male valvae during copulation, present along posterior margin of ventral area of 7th abdominal segment ; the sclerite continuous to copulatory cavity. Eighth abdominal segment 1/3 as high as 7th segment, uniformly sclerotized and continuous to the copulatory cavity ; a large and deep excavation, which is presumably hooked by uncus tip of the male genitalia during copulation, present on ventral portion of 8th sternum. Ostium bursae oval. Apophysis anterioris very short and weakly curved

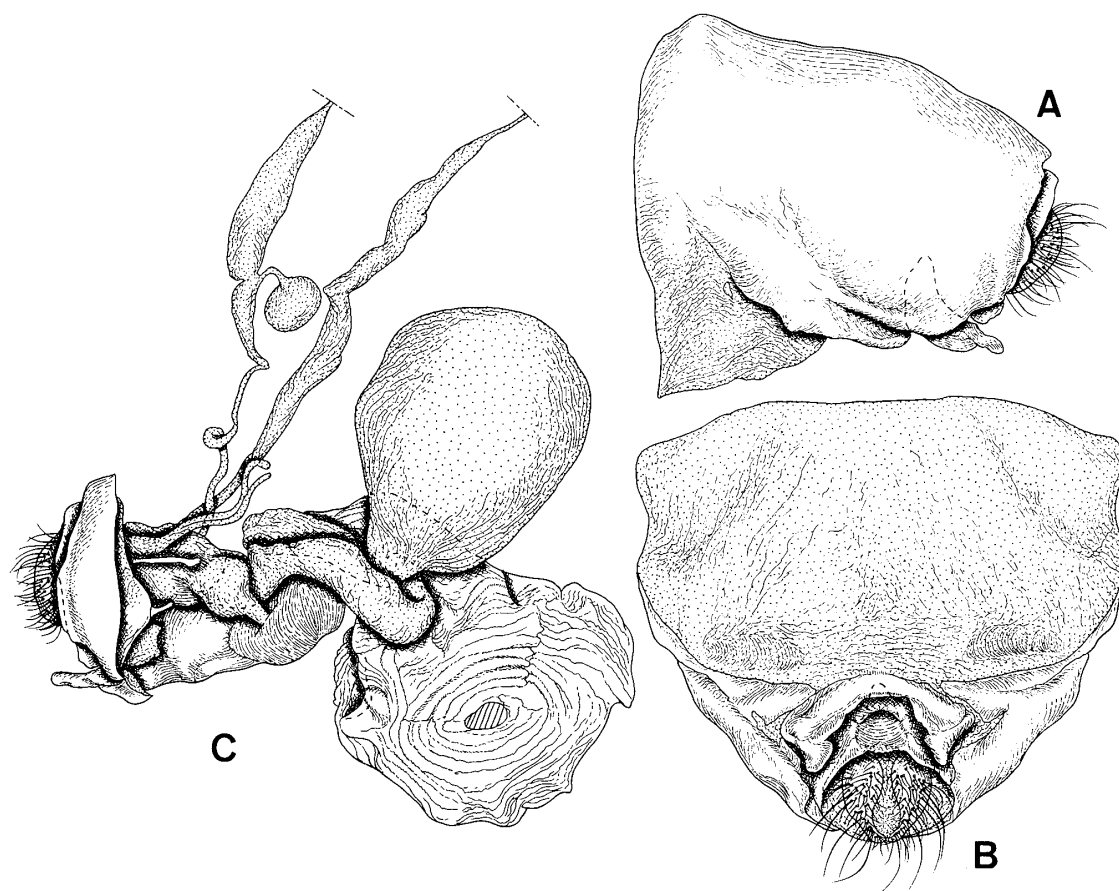


Fig. 33. Female external genitalia and internal reproductive organs of *Epicallia villica* (LINNAEUS). A. External genitalia in lateral view ; B. *Ditto* in posteroventral view ; C. Internal reproductive organs in lateral view (right).

dorsally, $1/14$ as long as height of 8th segment. Papilla analis in lateral view moderately large, semicircular, with dense short hairs and several long hairs ; apophysis posterioris slender, $4\times$ as long as apophysis anterioris.

Female internal reproductive organs : Bursa copulatrix reaching to posterior $1/3$ of 6th segment. Antrum very narrow. Membranous area between antrum and ductus bursae absent. Ductus bursae $2/5$ as long as bursa copulatrix, rather thick, weakly curved dorsally, ventral surface of anterior $1/2$ weakly concaved. Cervix bursae rather small and weakly sclerotized, with many complicated wrinkles on its entire surface. Corpus bursae moderately large and globular, $1/2$ as long as bursa copulatrix, bearing concentric circular wrinkles surrounding signum ; signa represented by a pair of circular plates bearing some small spinules. Lower part of ductus seminalis rather long, attached to dorsal portion of posterior end of cervix bursae, extending posteriorly and turned toward anteriorly, then continuous to bulla seminalis ; bulla seminalis very large and globular ; upper part of ductus seminalis rather thick, attached to left lateral side of base of bulla seminalis, directing posterodorsally and attached to left lateral side of vestibulum. Spermatheca fusiform. Glandula sevacea long, subequal in

length to bursa copulatrix. Scent gland bifurcate on its distal $2/3$.

This genus seems to be closely related to the genus *Arctia* in the structure of male and female genitalia. But this genus is different from *Arctia* in broad membranous ventral area of the female 7th abdominal segment which contains posteroventrally a pair of concaved areas.

I examined the genitalia of the following species.

1. *Epicallia villica* (LINNAEUS, 1758) (Figs. 32, 33, 54E, F)
Phalaena villica LINNAEUS, 1758, Syst. Nat. (Edn 10), 1: 501.
 Distribution: Europe and North Africa.

4.1.4.6 Genus *Pericallia* HÜBNER, [1820]

Pericallia HÜBNER, [1820], Verz. bekannter Schmett.: 182. Type species: *Phalaena matronula* LINNAEUS, 1758, by monotypy.

Pleretes LEDER, 1853, Verh. zool.-bot. Ver. Wen 2 (Abh.): 77. Type species: *Phalaena matronula* LINNAEUS, 1758, by monotypy.

Male external genitalia: Tegumen as long as uncus, in dorsal view almost triangular, broad at base and narrowed posteriorly, lateral margin of posterior $1/3$ rounded, anterodorsal margin strongly incised; in lateral view slender, subequal in height of vinculum; pedunculus rather long and slender; acrotergite weakly developed. Fens-trula appearing as a membranous spot; membranous slits between tegumen and uncus absent. Uncus in lateral view with basal $2/3$ produced to form a protuberance swollen posterodorsally, apical portion of uncus slender, ending in a weakly pointed tip, bearing short hairs dorsolaterally. Vinculum rather long and slender, $2/3$ as deep as ring; saccus small, $1/2$ as long as height of ring. Valva very large, basal $3/5$ nearly rectangular, constricted at subbasal portion of harpe+ampulla, apical $1/3$ spatulate; costa well developed, long and narrow, basal portion of costa produced to form a horn-like process directing dorsodistally; anellifer broad and occupying basal $3/5$ of valva; sacculus long and narrow, connected narrowly to ventroproximal part of harpe+ampulla by weakly sclerotized slender conjunction along ventral margin of valva; labides well developed, $1/5-1/4\times$ as long as valva, produced to form a clublike process with many dense short spinules on its apical $1/3$. Juxta almost rectangular in ventral view, with a membranous area on its middle portion of basal $2/3$. Phallus rather short; suprazonal sheath strongly curved dorsally at basal $1/2$, lateral perivesical area extensively developed and bearing dense minute spinules; subzonal sheath occupying $1/3$ of aedeagus; coecum penis well developed; vesica everted dorsally and ventrolaterally, about $1/2$ as long as aedeagus, with minute spinules on its almost entire surface.

Female external genitalia: Seventh abdominal tergum and sternum very large, distinctly separated by slender lateral membranous areas; the tergum including spiracles. Eighth abdominal segment $2/5$ as high as 7th abdominal segment, uniformly sclerotized and continuous to copulatory cavity; 8th abdominal sternum with a median deep excavation and a pair of deep round lateral concavities, the uncus tip of

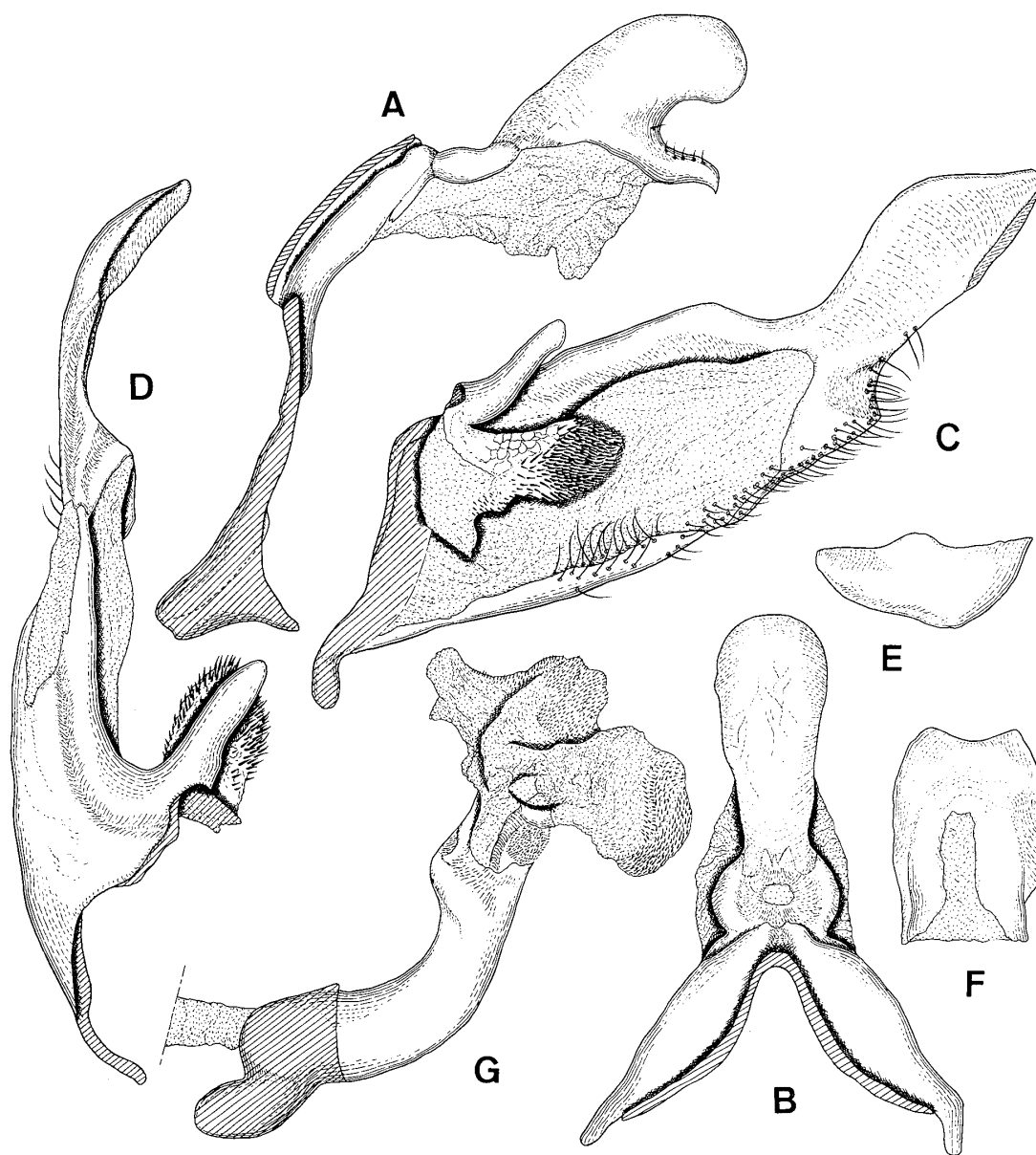


Fig. 34. Male external genitalia of *Pericallia matronula* (LINNAEUS). A. Ring in lateral view ; B. Dorsum in dorsal view ; C. Inside of right valva ; D. *Ditto* in dorsal view ; E. Juxta in lateral view ; F. *Ditto* in ventral view ; G. Phallus in lateral view.

the male genitalia is hooked into the median excavation in copula ; lamella postvaginalis rather wide and flat, situated just before 8th sternum, with several longitudinal furrows on its entire surface. Apophysis anterioris short and slender, $1/4$ as long as 8th segment. Papilla analis in lateral view moderately large and semicircular, with dense short hairs ; membranous subanal area weakly concaved, the area is pushed up by the protuberance of uncus of male genitalia when copulating in ventral view ; apophysis posterioris short, subequal in length to apophysis anterioris.

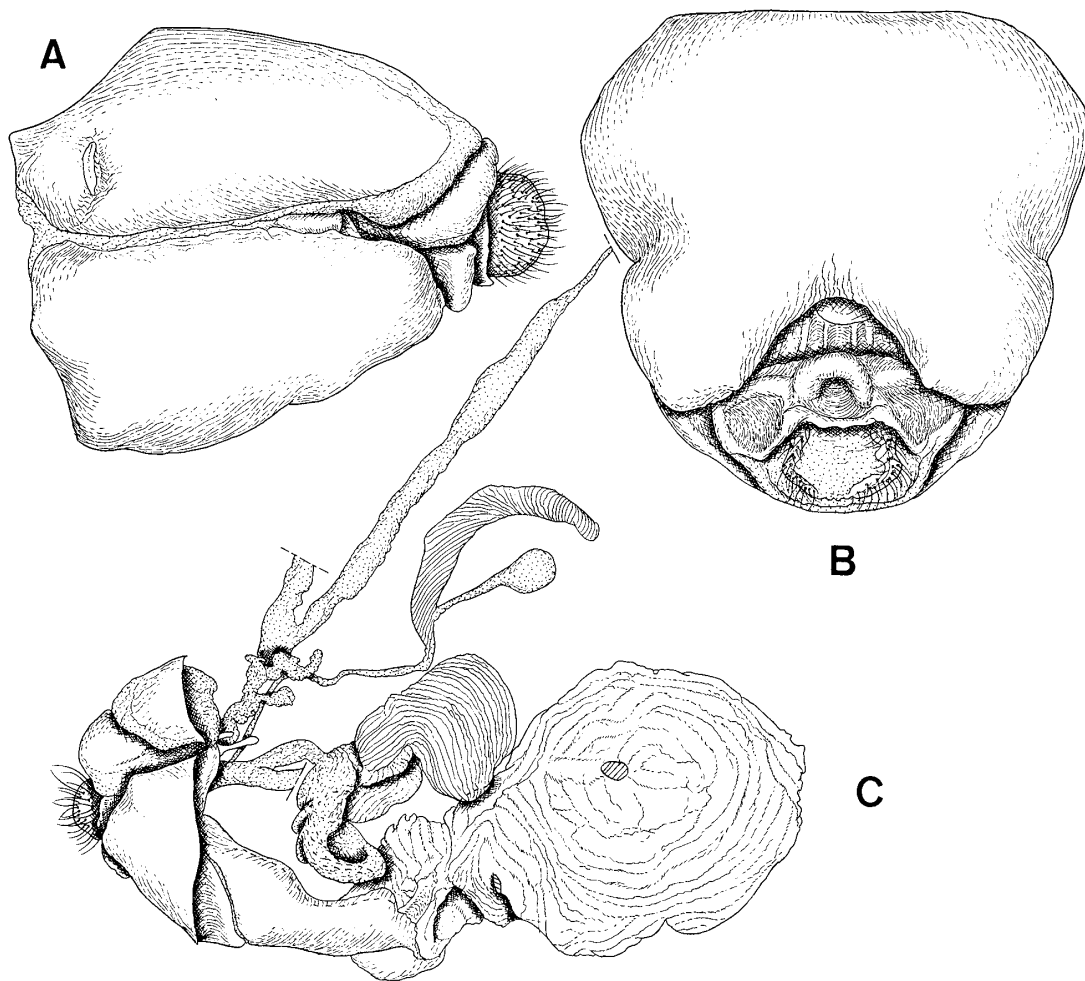


Fig. 35. Female external genitalia and internal reproductive organs of *Pericallia matronula* (LINNAEUS). A. External genitalia in lateral view ; B. *Ditto* in postero-ventral view ; C. Internal reproductive organs in lateral view (right).

Female internal reproductive organs : Bursa copulatrix reaching to anterior end of 6th abdominal segment. Ostium bursae circular ; antrum sclerotized ; a narrow membranous slit present between antrum and ductus bursae. Ductus bursae nearly straight, sclerotized and its dorsal surface strongly concaved longitudinally, $1/3$ as long as bursa copulatrix. Cervix bursae weakly sclerotized, with many complicated furrows on its entire surface. Corpus bursae in lateral view large and oval, $1/2$ as long as bursa copulatrix, bearing concentric wrinkles surrounding signum ; signa represented by a pair of circular plates bearing some small spinules. Lower part of ductus seminalis moderately long, attached to posterior $1/4$ of dorsal surface of cervix bursae, extending posterodorsally and curved anteroventrally, then recurved posterodorsally at level of posterior $1/3$ of cervix bursae and extending dorsally ; bulla seminalis large, $1/2$ as long as corpus bursae ; upper part of ductus seminalis short, arising from dorsal corner of bulla seminalis, attached to left lateral side of vestibulum. Spermatheca crescent-shaped. Glandula sevacea rather moderately long and

slender. Scent gland rather complicated.

This genus is very characteristic in having the protuberance on the male uncus, the costal process of the male valva and the concaved subanal area of the female terminalia. Only one species is included in this genus.

1. *Pericallia matronula* (LINNAEUS, 1758) (Figs. 34, 35, 54G, H)

Phalaena matronula LINNAEUS, 1758, Syst. Nat. (Edn 10), 1: 509.

Distribution: From Eastern France throughout Europe to the Amur, Korea and Japan (Hokkaido and Honshu).

4.1.5 The *Rhyparioides* genus group

The *Rhyparioides* genus group is characterized by the following autapomorphies: In male genitalia, dorsal 1/2 of harpe+ampulla of valva shallowly but distinctly concaved; in female genitalia, lamella postvaginalis with a small sclerotized invagination.

This genus group contains the following six genera, *Grammia* RAMBUR, *Chelis* RAMBUR, *Hyperborea* GRUM-GRSHIMAILO, *Diacrisia* HÜBNER, *Rhyparia* HÜBNER and *Rhyparioides* BUTLER.

4.1.5.1 Genus *Grammia* RAMBUR, 1866

Grammia RAMBUR, 1866, Cat. syst. Lepid. Andalousia, 29: 261. Type species: *Bombyx quenseli* PAYKULL 1793, by monotypy.

Orodemnias WALLENGREN, 1885, Skand. Heterocer-Fjarilar, 2 (3) 315. Type species: *Bombyx quenseli* PAYKULL, 1793, by monotypy.

Male external genitalia: Tegumen slightly shorter than uncus, divided into strongly sclerotized anterior and weakly sclerotized posterior parts; in dorsal view broad at base and narrowed posteriorly, lateral margin of posterior 1/2 nearly parallel-sided, anterodorsal portion strongly incised; in lateral view tegumen lower than vinculum; pedunculus moderately long; acrotergite weakly developed. Fenestrula rather broad; membranous slits between tegumen and uncus absent. Uncus in dorsal view broad at base and gradually tapering to apex; in lateral view long and slender, apical 1/3 weakly curved ventrally and weakly pointed at apex, sparsely short-haired on basal 2/3. Vinculum long and slender, 2/3 as deep as ring; saccus moderately large. Valva moderately large; costa rather broad, continuous to dorsoproximal portion of harpe+ampulla; basal 1/2 of harpe+ampulla broad and its inner wall weakly concaved, dorsodistal portion of harpe+ampulla shortly produced; anellifer broad and occupying 1/2 of inner wall of valva; sacculus narrow and short; transtilla scarcely elongated inwardly. Juxta nearly crescent-shaped in ventral view. Phallus short and thick; suprazonal sheath strongly curved dorsally, without carina penis; subzonal sheath about 1/2 as long as aedeagus; coecum penis slightly developed; vesica everted dorsally and laterally, more than 2/3 as long as aedeagus; cornuti represented by

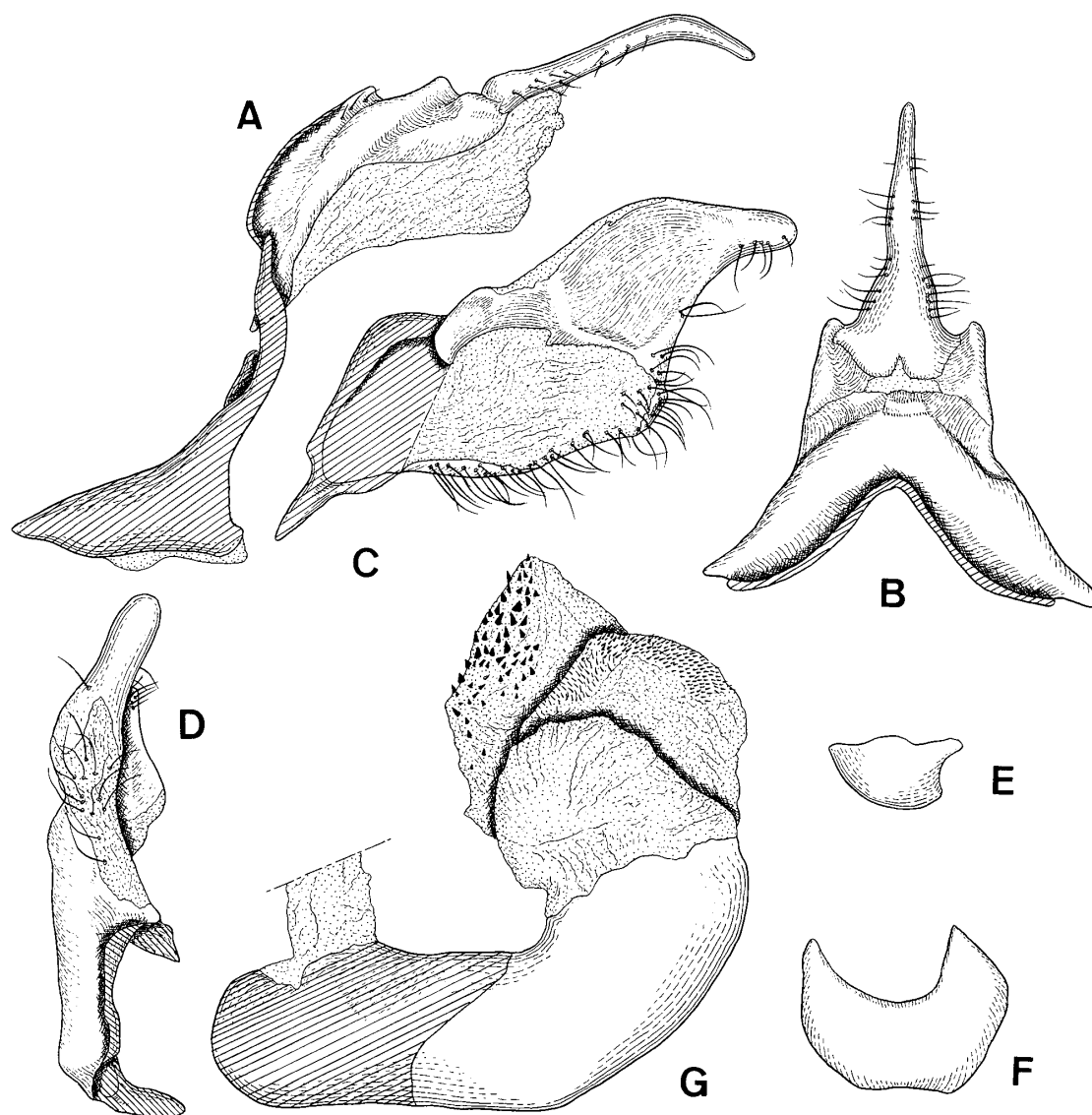


Fig. 36. Male external genitalia of *Grammia quenseli* (PAYKULL). A. Ring in lateral view ; B. Dorsum in dorsal view ; C. Inside of right valva ; D. *Ditto* in dorsal view ; E. Juxta in lateral view ; F. *Ditto* in ventral view ; G. Phallus in lateral view.

many short denticles on its dorsoproximal portion and minute spinules on its dorsal 1/3.

Female external genitalia : Seventh abdominal tergum and sternum large. Eighth abdominal segment 1/3 as high as 7th segment, uniformly sclerotized and continuous to the copulatory cavity. A small sclerotized invagination, which is hooked by uncus tip of the male genitalia during copulation, present on middle portion of lamella postvaginalis. Ostium bursae circular. Apophysis anterioris very short, 1/14 as long as height of 8th segment. Papilla analis in lateral view trapezoid, with weakly emarginate terminal margin, bearing many hairs ; apophysis posterioris rather long, 6× as long as apophysis anterioris.

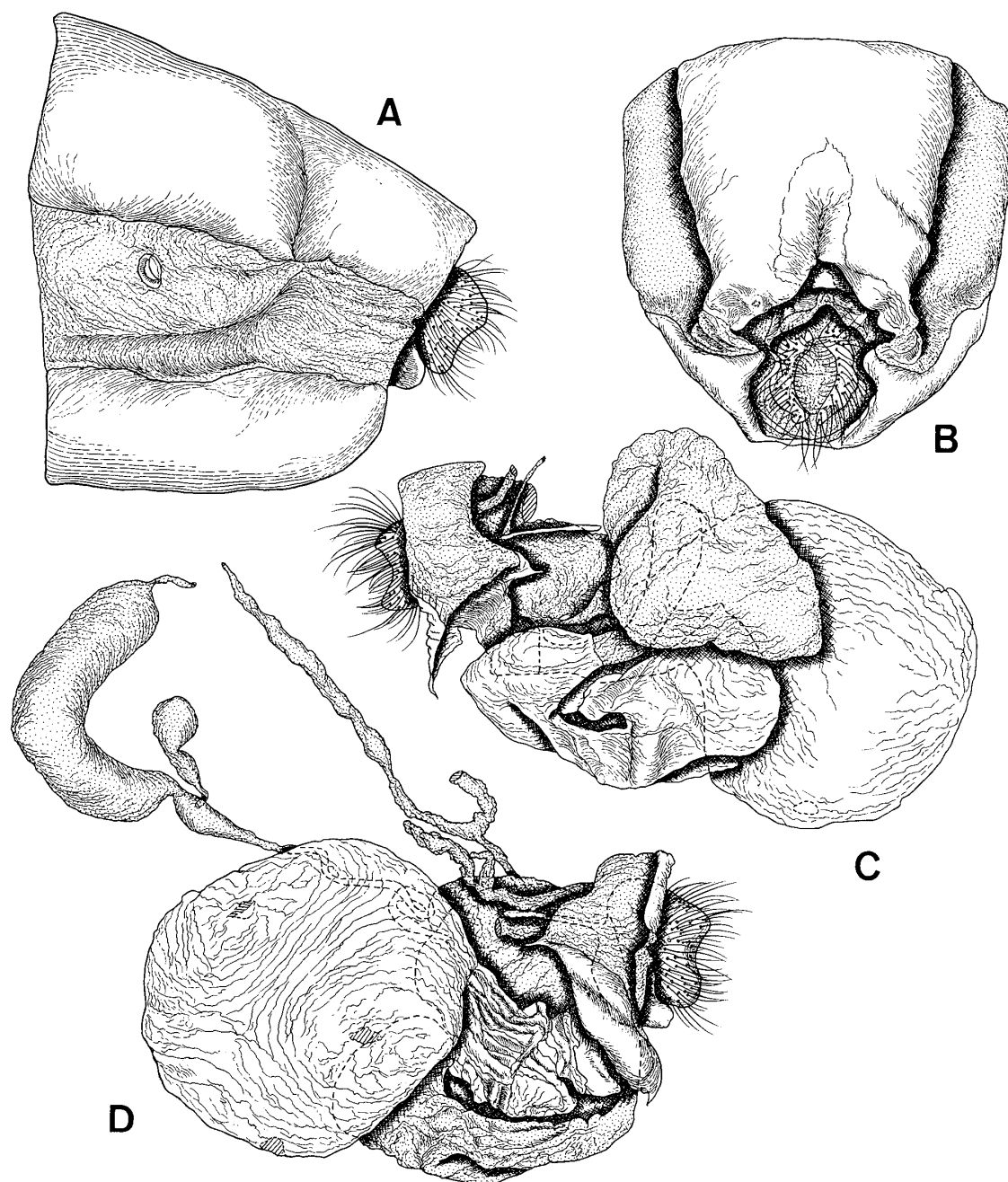


Fig. 37. Female external genitalia and internal reproductive organs of *Grammia quenseli* (PAYKULL). A. External genitalia in lateral view ; B. *Ditto* in postero-ventral view ; C. Internal reproductive organs in lateral view (right) ; D. *Ditto* in lateral view (left).

Female internal reproductive organs : Anterior end of bursa copulatrix reaching to posterior 1/2 of 6th segment. Antrum rather short and thick, extending to ductus bursae. Ductus bursae short and rather thick, weakly sclerotized. Cervix bursae well developed and sclerotized, weakly curved dorsally, with many irregular rows of furrows on its entire surface, attached to posterior portion of right lateral side of corpus bursae. Corpus bursae membranous and globular, 3/5 as long as bursa copulatrix ; signa which are three circular plates bearing some small spinules. Lower

part of ductus seminalis rather thick, arising from posterior 1/2 of right lateral side of cervix bursae and curved dorsally, attached to middle portion of left lateral side of bulla seminalis; bulla seminalis very large, situated at right side of posterodorsal portion of corpus bursae, attached to right ventral portion of vestibulum. Spermatheca allantoid. Glandula seviceae slender, 3/5 as long as bursa populatrix. Scent gland rather long, with a short branch.

The male genitalia of this genus clearly show that they are not only similar to those of *Rhyparioides* in their fundamental structure but also have all the autapomorphies of the *Rhyparioides* genus group. But I could not find the apomorphic character present only in this genus, so strict monophyly of this genus is not determined.

This genus includes only one species, *quenseli*, from the Palearctic Region. But this genus seems to be closely related to the genus *Apantes* WALKER (Nearctic Region) in the structure of the male genitalia.

1. *Grammia quenseli* (PAYKULL, 1793) (Figs. 36, 37, 55A, B)

Bombyx quenseli PAYKULL, 1793, Skr. Naturh. -Selsk. Kiøbenhavn, 2 (2): 99, fig.

Distribution: Europe (Riffers Alps, Antholzer Alps, Daniser Alps and Lapland), East Siberia, West Amur and Japan (Mts. Taisetsu of Hokkaido).

4.1.5.2 Genus *Chelis* RAMBUR, 1866

Chelis RAMBUR, 1866, Cat. syst. Lepid. Andalousie (2): 256. Type species: *Phalaena maculosa* [DENIS & SCHIFFERMÜLLER], 1775, by subsequent designation by KIRBY, 1892, Synonymic Cat. Lepid. Heterocera, 1: 263.

Male external genitalia: Tegumen longer than uncus, divided into anterior and weakly sclerotized posterior parts; pedunculus short; acrotergite weakly developed. Fenestrula appearing as a small spot; lateral membranous slits between tegumen and uncus absent. Uncus moderately long and sparsely with minute hairs, in lateral view swollen at base and weakly tapered to apex, apical 1/2 weakly curved posterodorsally. Vinculum rather thick, 2/3 as deep as ring; saccus very large, 2/3 as long as height of ring. Valva moderate in size; costa narrow and short; basal portion of harpe + ampulla broad basally, dorsodistal portion produced dorsally to form a semioval process, inner wall of harpe + ampulla concaved; anellifer occupying basal 2/3 of inner wall of valva; sacculus narrow on basal 2/3, expanded on apical 1/3 and with many long hairs. Juxta very large and nearly trapezoidal, subequal in length to valva, with strongly incised anterior margin. Phallus long; suprazonal sheath weakly curved dorsally at the middle; lateral perivesical area bearing many short spines; subzonal sheath 1/3 as long as aedeagus; coecum penis moderately long; vesica very large and broad, 2/3 as long as aedeagus, everted anteriorly, with minute spinules on its dorsomedian portion.

This genus has the following apomorphic characters in the male genitalia. The saccus is well developed; the vesica of aedeagus is everted anteriorly; the perivesical area of aedeagus is provided with many distinct short spines.

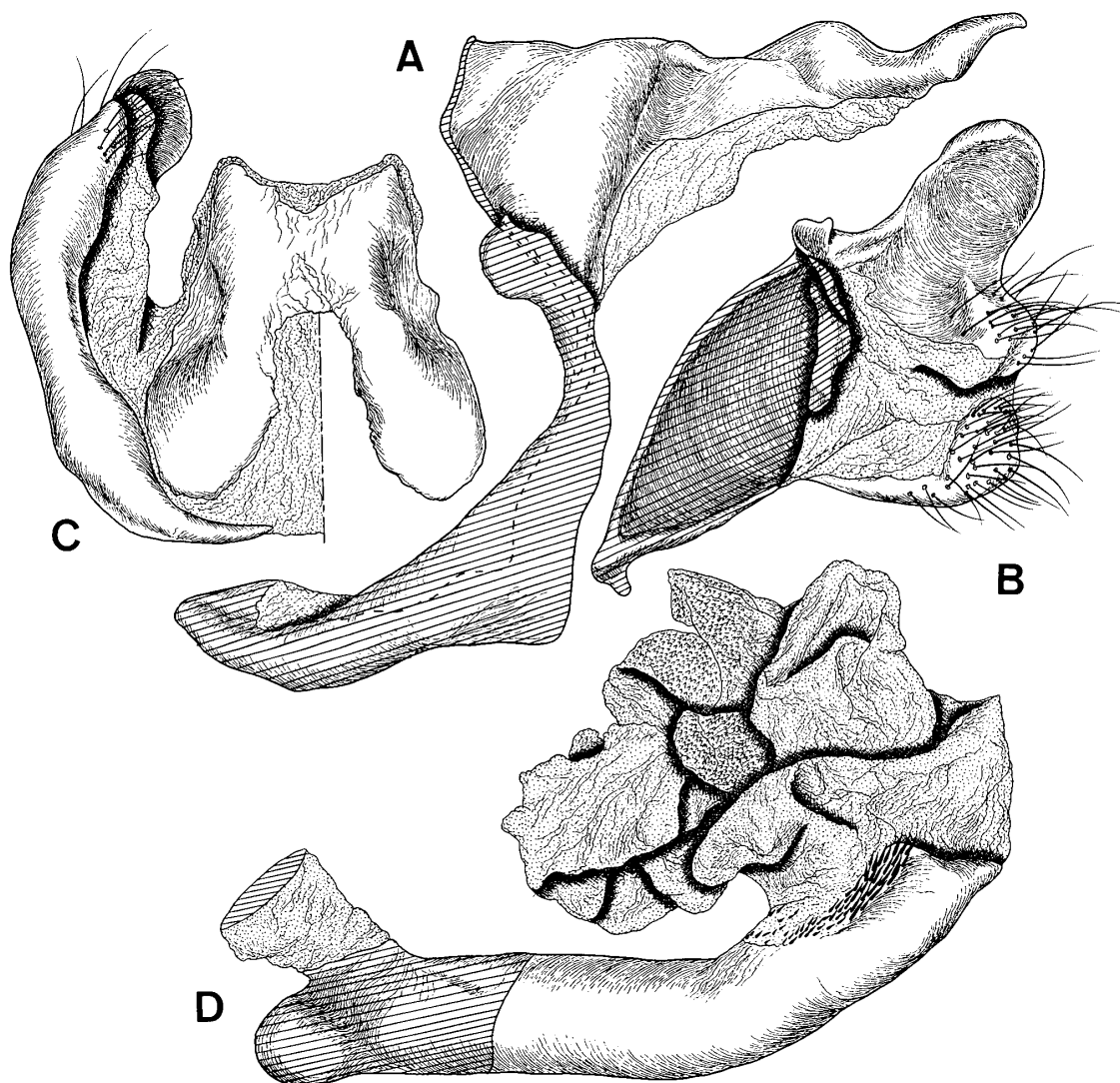


Fig. 38. Male external genitalia of *Chelis maculosa* ([DENIS & SCHIFFERMÜLLER]). A. Ring in lateral view ; B. Inside of right valva ; C. Left valva and juxta in ventral view ; D. Phallus in lateral view.

I examined the male genitalia of the following species.

1. *Chelis maculosa* ([DENIS & SCHIFFERMÜLLER], 1775) (Figs. 38. 55C)
Phalaena maculosa [DENIS & SCHIFFERMÜLLER], 1775, Ankundung syst. Werkes
 Schmett. Wienergegend : 54.

Distribution : Europe, Turkistan, Ural, Altai and South Siberia.

4.1.5.3 Genus *Hyperborea* GRUM-GRSHIMAILO, 1900

Hyperborea GRUM-GRSHIMAILO, 1900, Ezheg. zool. Mus., 4 : 464. Type species : *Hyperborea czekanowskii* GRUM-GRSHIMAILO, 1900, by monotypy.

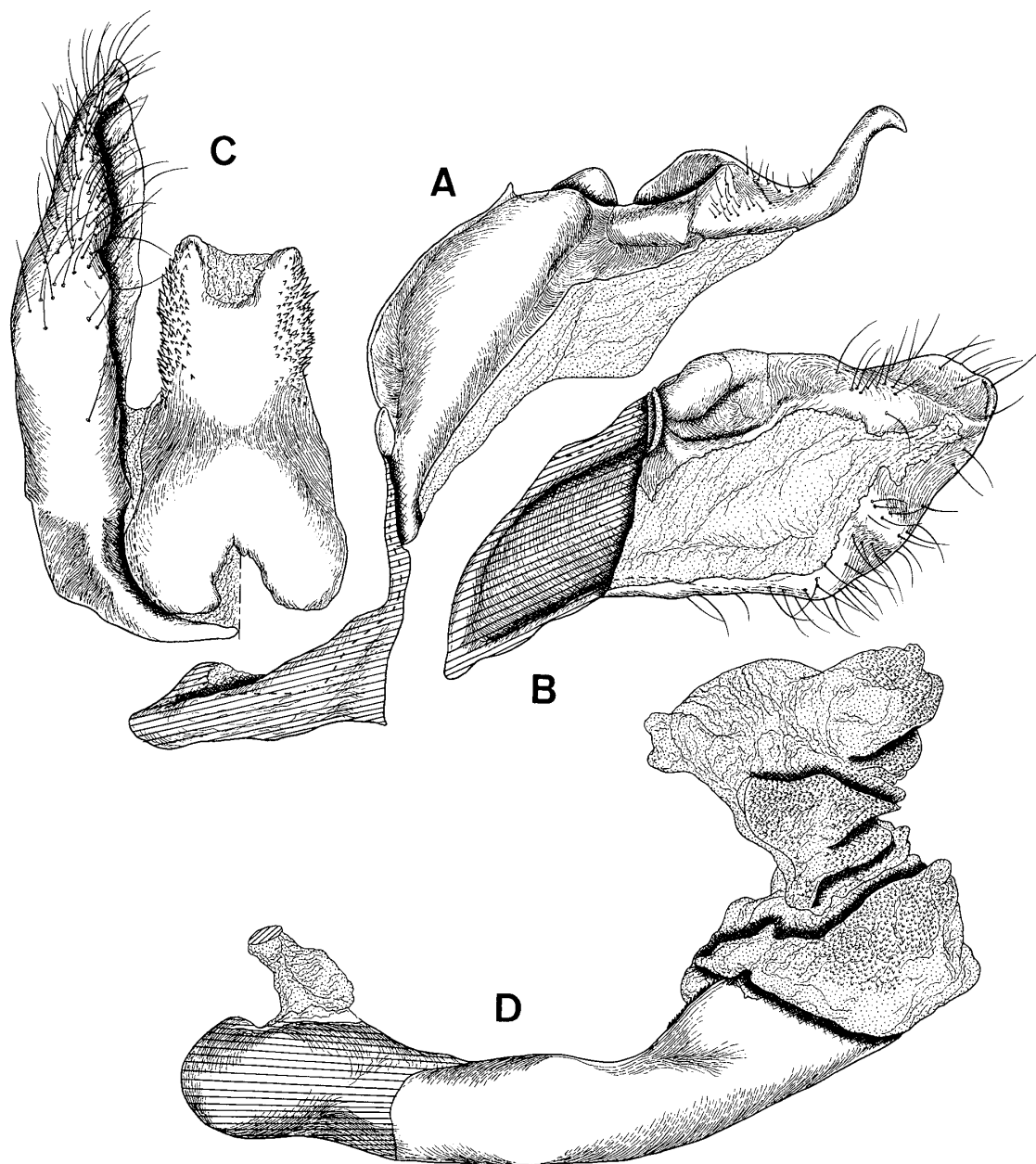


Fig. 39. Male external genitalia of *Hyperborea czekanowskii* GRUM-GRSHIMAILO. A. Ring in lateral view ; B. Inside of right valva ; C. left valva and juxta in ventral view ; D. Phallus in lateral view.

Male external genitalia : Tegumen moderately large, longer than uncus, divided into anterior and posterior parts ; posteromedian portion of posterior part swollen ; pedunculus rather short and slender ; acrotergite slightly developed. Fenestrula appearing as a narrow longitudinal area ; lateral membranous slits between tegumen and uncus absent. Uncus moderate in size, swollen at base and tapered to apex, curved dorsally at basal 1/2 and recurved at apical 1/5, sparsely with short hairs. Vinculum slender, 1/3 as deep as ring ; saccus large and long, 1/2 as long as height of ring. Valva

moderately large, nearly oval; costa broad, middle portion of inner wall of costa strongly concaved; harpe+ampulla indistinct, dorsodistal portion of inner wall of harpe+ampulla concaved, continuous to sacculus, with sparsely haired; anellifer occupying basal 2/3 of inner wall of valva; sacculus long, basal 1/2 slender, curved dorsally at middle, apical 1/2 rather broad, with sparsely hairs. Juxta very large, nearly rectangular, bearing many minute spinules on lateral portion of distal 1/2. Phallus long and thick; suprazonal sheath slightly curved dorsally, with a small serrate carina penis on its dorsodistal portion; subzonal sheath 1/3 as long as aedeagus; coecum penis weakly developed; vesica large, 1/2 as long as aedeagus, everted dorsally, with many minute spinules on its entire surface except for dorsodistal portion.

This genus is characteristic in having the following apomorphies: A small serrate carina penis of aedeagus; juxta with many minute spinules.

This genus seems to be closely related to the following three genera in the structure of the male genitalia. But the marking and ground colour of the wings of this genus are entirely different from those of these genera.

This genus includes only one species, *czekanowskii*, in the world.

1. *Hyperborea czekanowskii* GRUM-GRSHIMAILO, 1900 (Figs. 39, 55D)

Hyperborea czekanowskii GRUM-GRSHIMAILO, 1900, *Ezheg. zool. Mus.*, 4: 464.

Distribution: East Siberia (Tungusku) and North Korea.

4.1.5.4 Genus *Diacrisia* HÜBNER, [1819]

Diacrisia HÜBNER, [1819], *Verz. bekannter Schmett.*: 169. Type species: *Phalaena russula* LINNAEUS, 1758, by monotypy.

P. russula is a junior subjective synonym of *Phalaena sannio* LINNAEUS, 1758.

Euthemonia STEPHENS, 1828, *Illust. Br. Ent. (Haustellate)*, 2: 55 (Key), 68. Type species: *Phalaena russula* LINNAEUS, 1758, by monotypy.

Elpis DYER, 1893, *Ent. News* 4: 36. Type species: *Antarctia rubra* NEUMÖGEN, 1881, *Papilio*, 1: 79, by original designation.

Male external genitalia: Tegumen rather thick, divided into anterior and posterior parts; in dorsal view broad basally, weakly narrowed posteriorly, dorsomedian portion of anterior part weakly concaved, posterior part weakly expanded laterally at the level of fenestrula; in lateral view 1/2 as high as ring; pedunculus rather narrow; acrotergite slightly developed. Fenestrula appearing as a rather broad median area and a pair of lateral spots; lateral membranous slit between tegumen and uncus absent. Uncus in dorsal view broadly rounded at base, apical 2/3 slender; in lateral view slender, slightly curved ventrally and tapered towards sharply pointed tip, with several short hairs laterally. Vinculum rather slender 2/3 as deep as ring; saccus thick, 1/2 as long as height of ring. Valva medium in size; costa narrow and extending and continuing to dorsoproximal portion of harpe+ampulla; harpe+ampulla rather broad, dorsodistal portion protruding posterodorsally, inner wall concaved, basal portion produced to form a semicircular process which bears dense

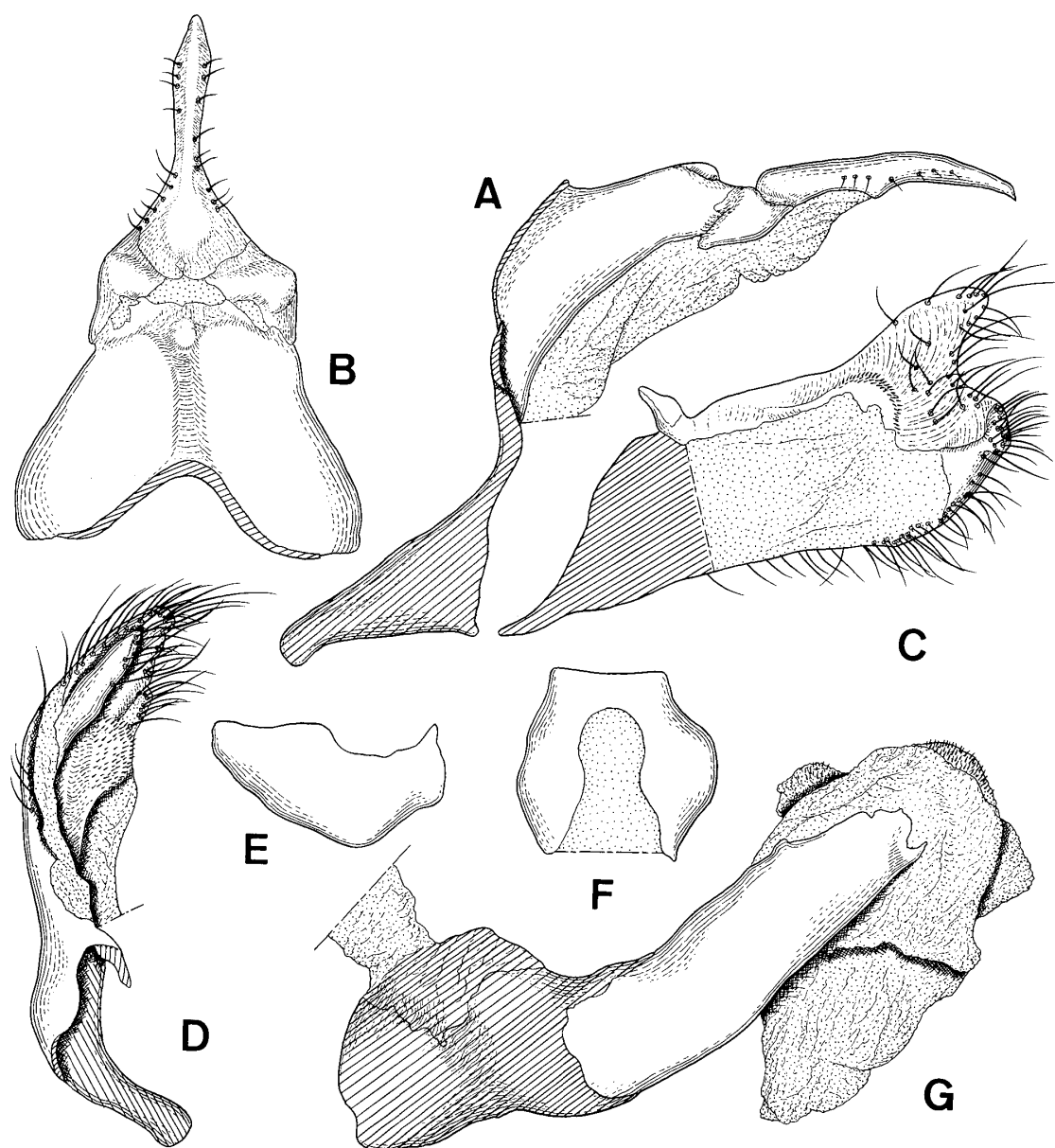


Fig. 40. Male external genitalia of *Diacrisia sannio* (LINNAEUS). A. Ring in lateral view ; B. Dorsum in dorsal view ; C. Inside of right valva ; D. *Ditto* in dorsal view ; E. Juxta in lateral view ; F. *Ditto* in ventral view ; G. Phallus in lateral view.

spinules on its dorsal surface, ventrodistal portion rounded, sparsely haired ; anellifer broad, $\frac{2}{3}$ as wide as valva ; sacculus absent. Juxta almost rectangular, with membranous area on its median portion in ventral view, no spinules on juxta. Phallus moderately long ; suprazonal sheath directing posterodorsally, without carina penis ; subzonal sheath rather thick, less than $\frac{1}{2}$ as long as aedeagus ; coecum penis slightly developed ; vesica everted ventrolaterally, with minute spinules on its dorsal surface.

Female external genitalia : Seventh abdominal tergum well developed ; 7th sternum absent so that ventral $\frac{2}{3}$ of this segment entirely membranous. Eighth abdominal segment $\frac{1}{3}$ as high as 7th segment in lateral view, uniformly sclerotized, with a

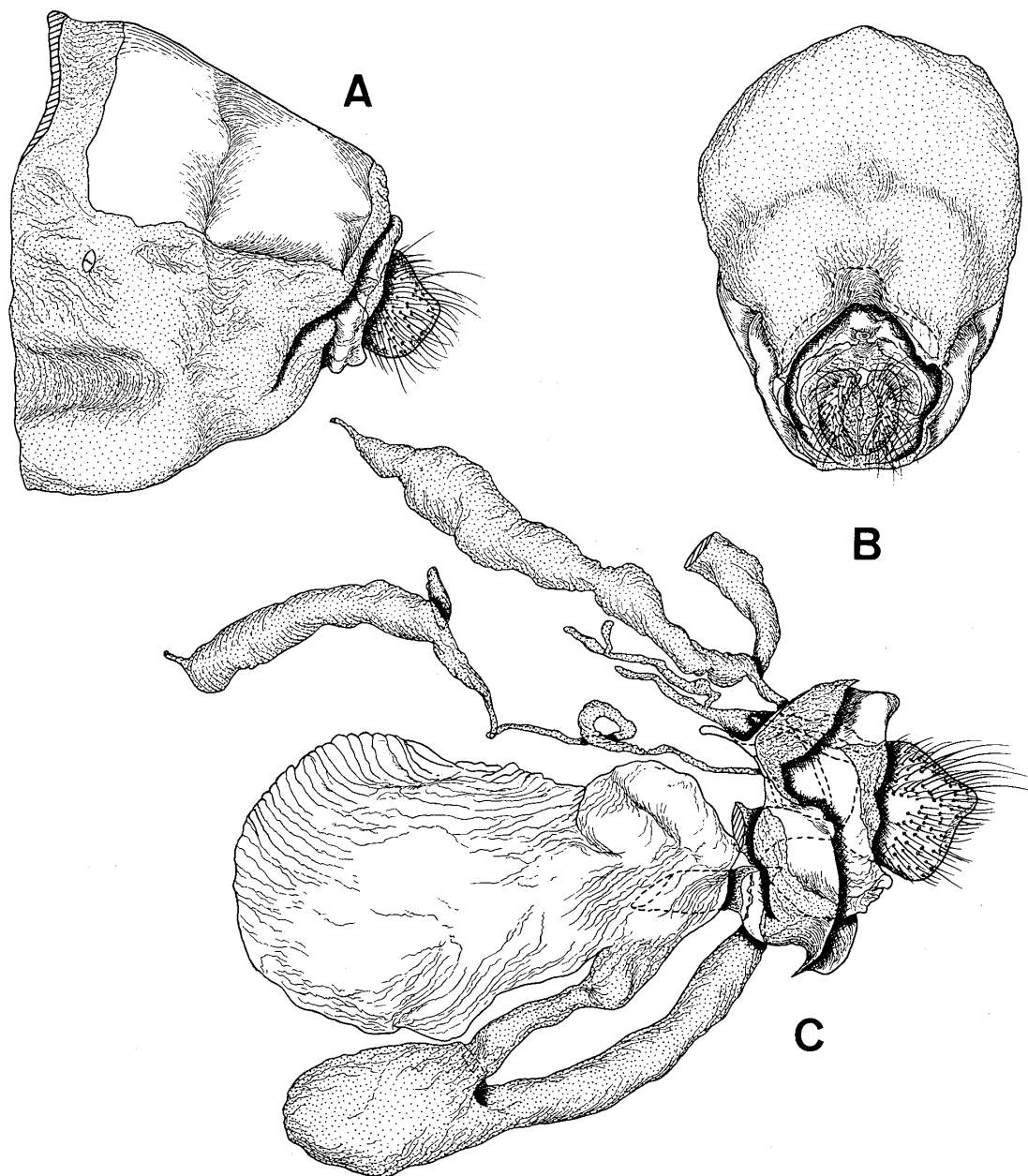


Fig. 41. Female external genitalia and internal reproductive organs of *Diacrisia sannio*. (LINNAEUS). A. External genitalia in lateral view ; B. *Ditto* in posteroventral view ; C. Internal reproductive organs in lateral view (left).

pair of triangular lateral membranous incisions. Lamella antevaginalis wide, completely fused with lamella postvaginalis laterally. Lamella postvaginalis with a small sclerotized invagination which is hooked by uncus tip of the male genitalia during copulation. Ostium bursae oval and membranous. Apophysis anterioris short, weakly curved anterodorsally, $2/7$ as long as height of 7th segment. Papilla analis moderate in size, with many short hairs and several long hairs ; apophysis posterioris, $2\times$ as long as apophysis anterioris.

Female internal reproductive organs : Anterior end of bursa copulatrix reaching to posterior 1/3 of 6th segment. Antrum narrowed at short membranous area. Ductus bursae straight, 1/5 as long as bursa copulatrix, attached to posterior 2/3 of right lateral side of cervix bursae. Cervix bursae moderately large. Corpus bursae moderately large, oval, 3/5 as long as bursa copulatrix ; signa which are represented by a pair of small circular plates bearing several spinules. Lower part of ductus seminalis rather thick, attached to ventral surface of cervix bursae and extending to anteroventrally ; bulla seminalis oval, 1/2 as long as corpus bursae, situated beneath corpus bursae ; upper part of ductus seminalis rather long and thick, arising from ventrodistal portion of bulla seminalis, weakly curved dorsally and attached to ventral surface of vestibulum. Spermatheca fusiform. Glandula seivacea moderately large, 4/5 as long as bursa copulatrix. Scent gland rather complicated, with a long branch which has a short branch.

This genus is very characteristic in having the following autapomorphies : Harpe+ampulla of male valva with a semicircular process bearing dense spinules ; ductus seminalis and bulla seminalis of female situated beneath bursa copulatrix.

This genus includes only one species, *sannio*, in the world.

1. *Diacrisia sannio* (LINNAEUS, 1758) (Figs. 40, 41, 55E, F)

Phalaena sannio LINNAEUS, 1758, Syst. Nat. (Edn 10), 1 : 506.

Distribution : Palaearctic Region including Japan (Hokkaido and Honshu).

4.1.5.5 Genus *Rhyparia* HÜBNER, [1820]

Rhyparia HÜBNER, [1820], Verz. bekannter Schmett.: 183. Type species: *Phalaena purpurea* LINNAEUS, 1767, by subsequent designation by KIRBY, 1892, in Synonymic Cat. Lepid. Heterocera, 1 : 260.

P. purpurea is a junior subjective synonym of *Phalaena purpurata* LINNAEUS, 1758.

Male external genitalia : Tegumen in dorsal view broad at base and narrowed posteriorly, distinctly longer than uncus ; in lateral view rather slender, 3/7 as high as ring, with several short hairs laterally ; pedunculus rather long and slender ; acrotergite weakly developed. Fenestrula appearing as a long transeverse slit ; lateral membranous slit between tegumen and uncus absent. Uncus in dorsal view long and slender, basal 1/3 rather wide, evenly slender on apical 2/3 ; in lateral view basal 1/2 nearly straight, apical 1/2 slightly curved ventrally, tapered towards sharply pointed tip, uncus sparsely with short hairs laterally. Vinculum slender, 3/4 as high as ring ; saccus rather short and thick. Valva moderately large, almost rhombic ; costa narrow and continuing to dorsoproximal portion of harpe+ampulla which is strongly swollen and produced to form a semicircular process bearing many denticles ; harpe+ampulla long, dorsodistal portion produced dorsodistally, inner wall of dorsoproximal portion weakly concaved, sparsely haired ; anellifer broad, about 2/5 as long as valva ; sacculus long and narrow, continuous to ventroproximal portion of harpe+ampulla, with several hairs. Juxta rather large, semioval, with many minute denticles on distal 1/2

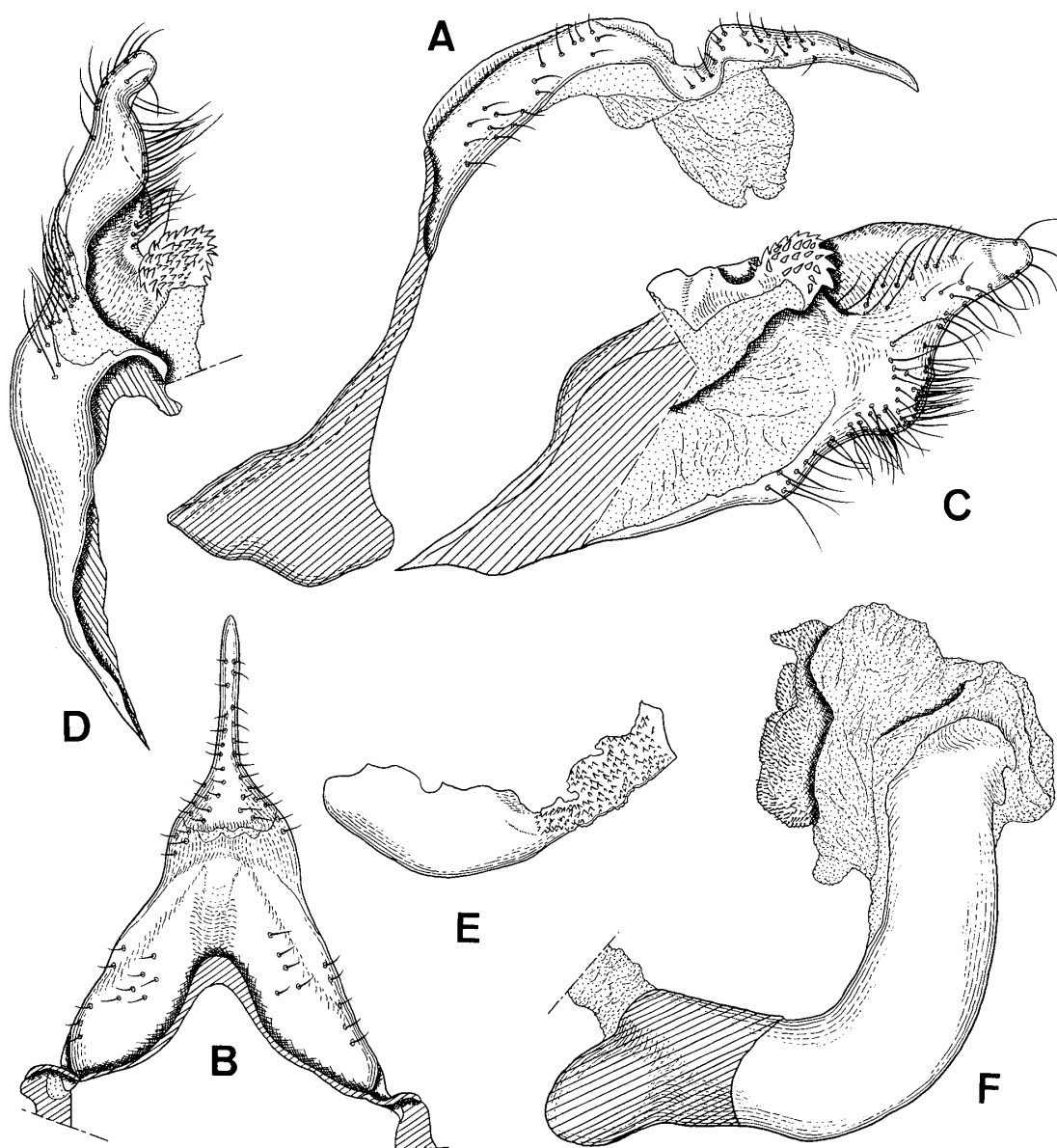


Fig. 42. Male external genitalia of *Rhyparia purpurata* (LINNAEUS). A. Ring in lateral view ; B. Dorsum in dorsal view ; C. Inside of right valva. D. *Ditto* in dorsal view ; E. Juxta in lateral view ; F. Phallus in lateral view.

of lateral surfaces. Phallus moderately long ; suprazonal sheath strongly curved dorsally at basal $1/5$, without carina penis ; subzonal sheath about $1/4$ as long as aedeagus ; coecum penis developed ; vesica everted laterally, about $1/2$ as long as aedeagus, with minute spinules on its right lateral surface.

This genus seems to be closely related to *Diacrisia* in the structure of male genitalia. But *Rhyparia* is different from the latter in having the strongly curved suprazonal sheath of the aedeagus and the semicircular process bearing many denticles in the male valva.

I examined the male genitalia of the following species.

1. *Rhyparia purpurata* (LINNAEUS, 1758) (Figs. 42, 55G, H)

Phalaena purpurata LINNAEUS, 1758, Syst. Nat. (Edn 10), 1: 505.

Distribution: Throughout Europe with the exception of the West, and in North Asia to Japan (Honshu).

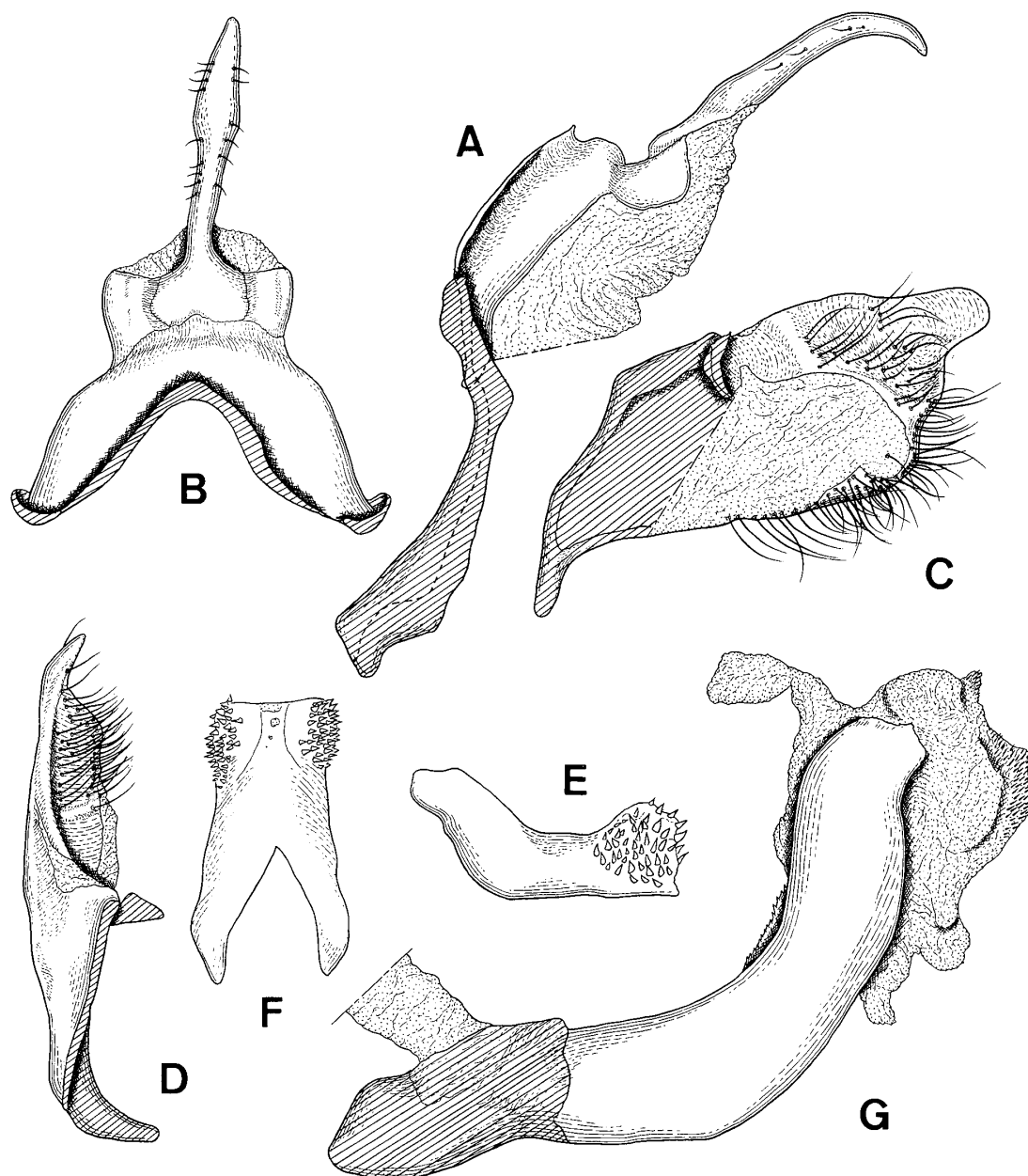


Fig. 43. Male external genitalia of *Rhyparioides amurensis* (BREMER). A. Ring in lateral view; B. Dorsum in dorsal view; C. Inside of right valva; D. *Ditto* in dorsal view; E. Juxta in lateral view; F. *Ditto* in ventral view; G. Phallus in lateral view.

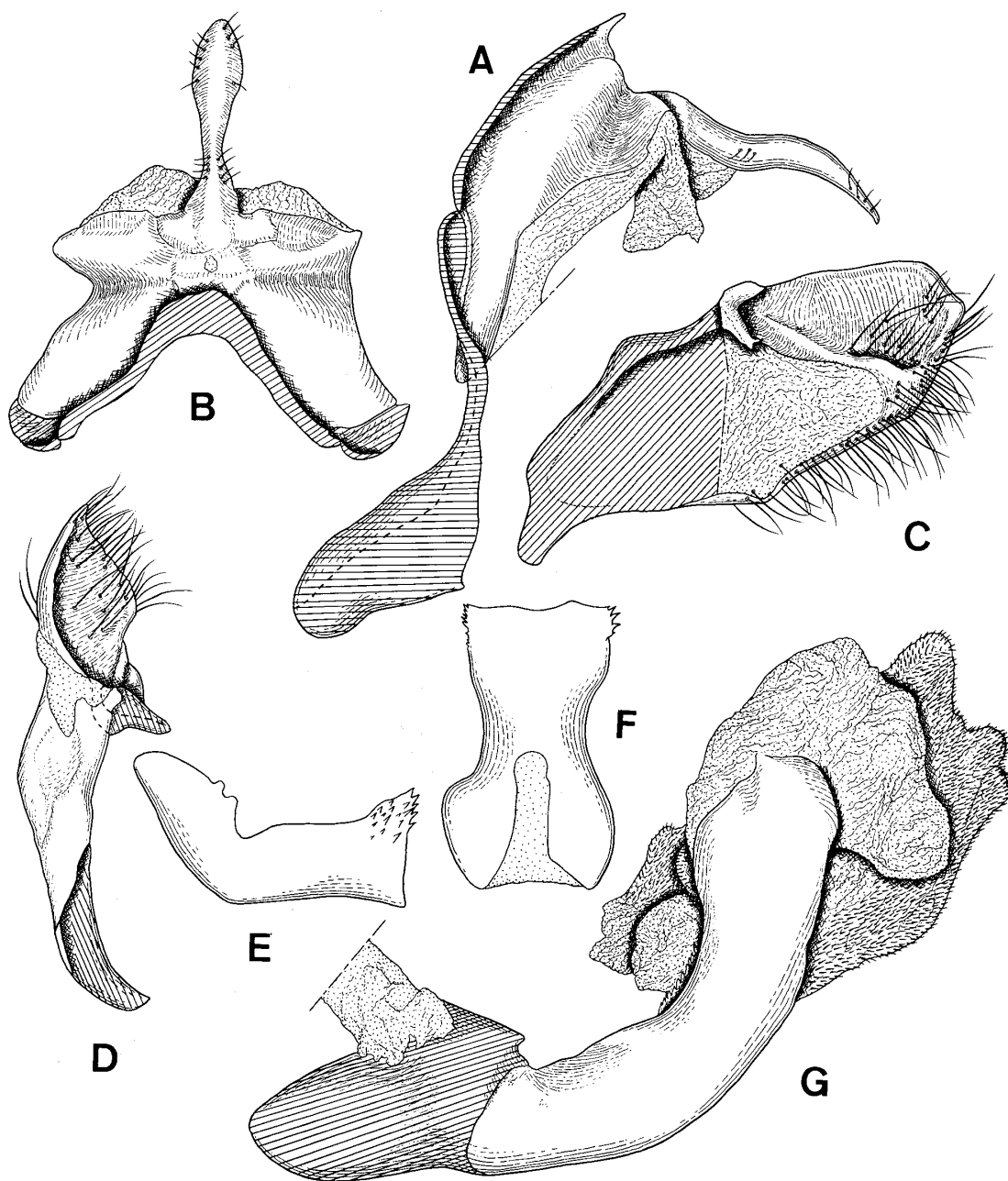


Fig. 44. Male external genitalia of *Rhyarioides metelkanus* (LEDERER). A. Ring in lateral view ; B. Dorsum in dorsal view ; C. Inside of right valva ; D. *Ditto* in dorsal view ; E. Juxta in lateral view ; F. *Ditto* in ventral view ; G. Phallus in lateral view.

4.1.5.6 Genus *Rhyarioides* BUTLER, 1877

Rhyarioides BUTLER, 1877, *Ann. Mag. nat. Hist.*, (4) 20 : 395. Type species: *Rhyarioides nebulosa* BUTLER, 1877, *ibidem*, (4) 20 : 396, by original designation.

Male external genitalia : Tegumen divided into strongly sclerotized anterior and

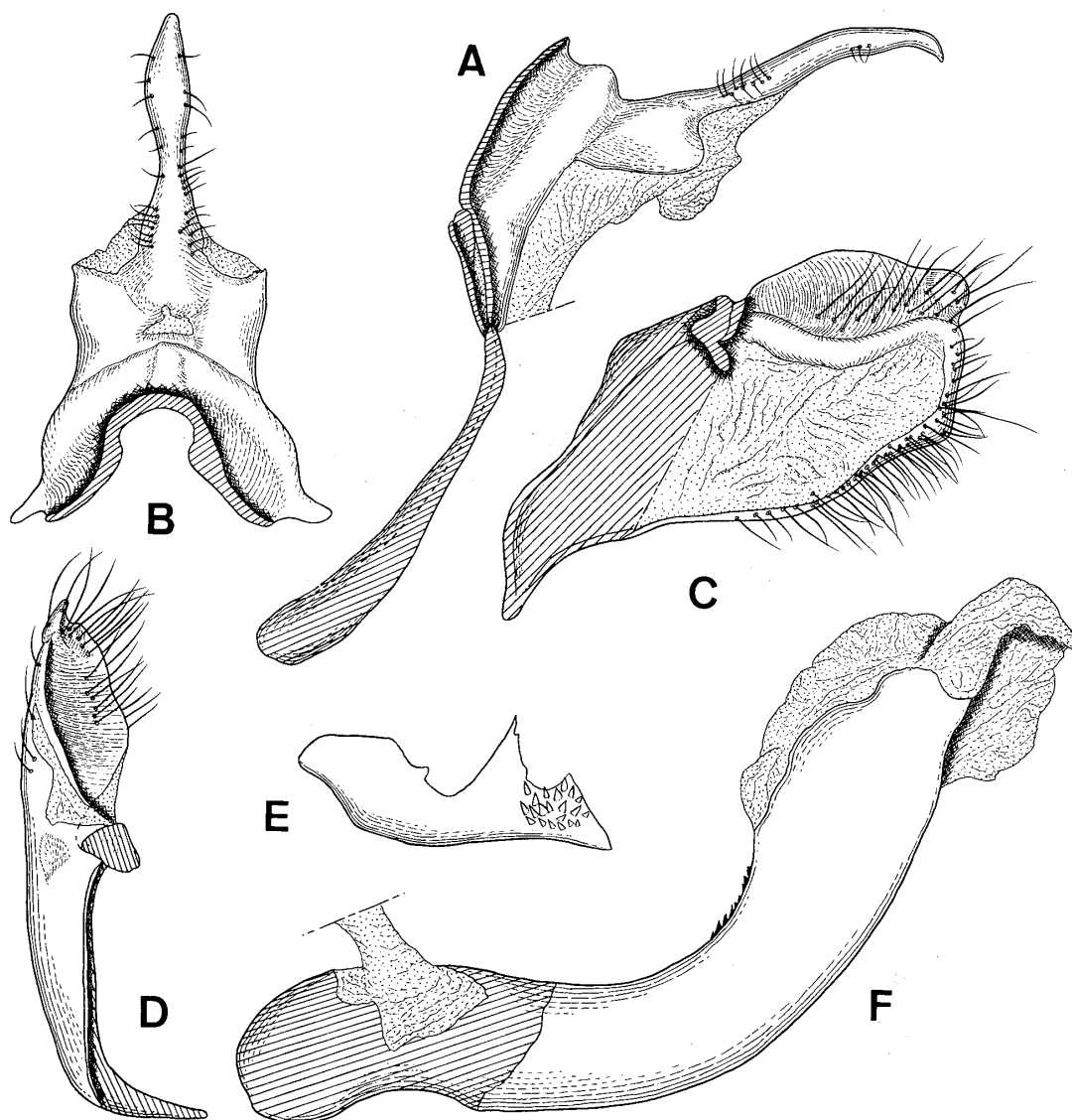


Fig. 45. Male external genitalia of *Rhyarioides nebulosus* BUTLER. A. Ring in lateral view ; B. Dorsum in dorsal view ; C. Inside of right valva ; D. Ditto in dorsal view ; E. Juxta in lateral view ; F. Phallus in lateral view.

weakly sclerotized posterior parts; anterior part in dorsal view broad at base and narrowed posteriorly; posterior part so expanded posterolaterally that it is broad, more or less parallel-sided and truncate posteriorly, and surrounds basal portion of uncus; in lateral view $2/5 - 1/2$ as high as ring; pedunculus usually short and narrow, but in *metelkanus* long and rather thick; acrotergite weakly developed. Fenestrula appearing as a broad or a small spot, but in *amurensis* absent. Uncus usually slender and long, but in *subvarius* thick and short; in lateral view basal $2/3$ directing posterodorsally and apical $1/3$ weakly curved ventrally, tapered towards weakly or sharply pointed tip, uncus with several short hairs laterally. Vinculum long and slender, $2/3 - 3/4$ as deep as ring; saccus usually rather small but in *metelkanus* and *subvarius* well

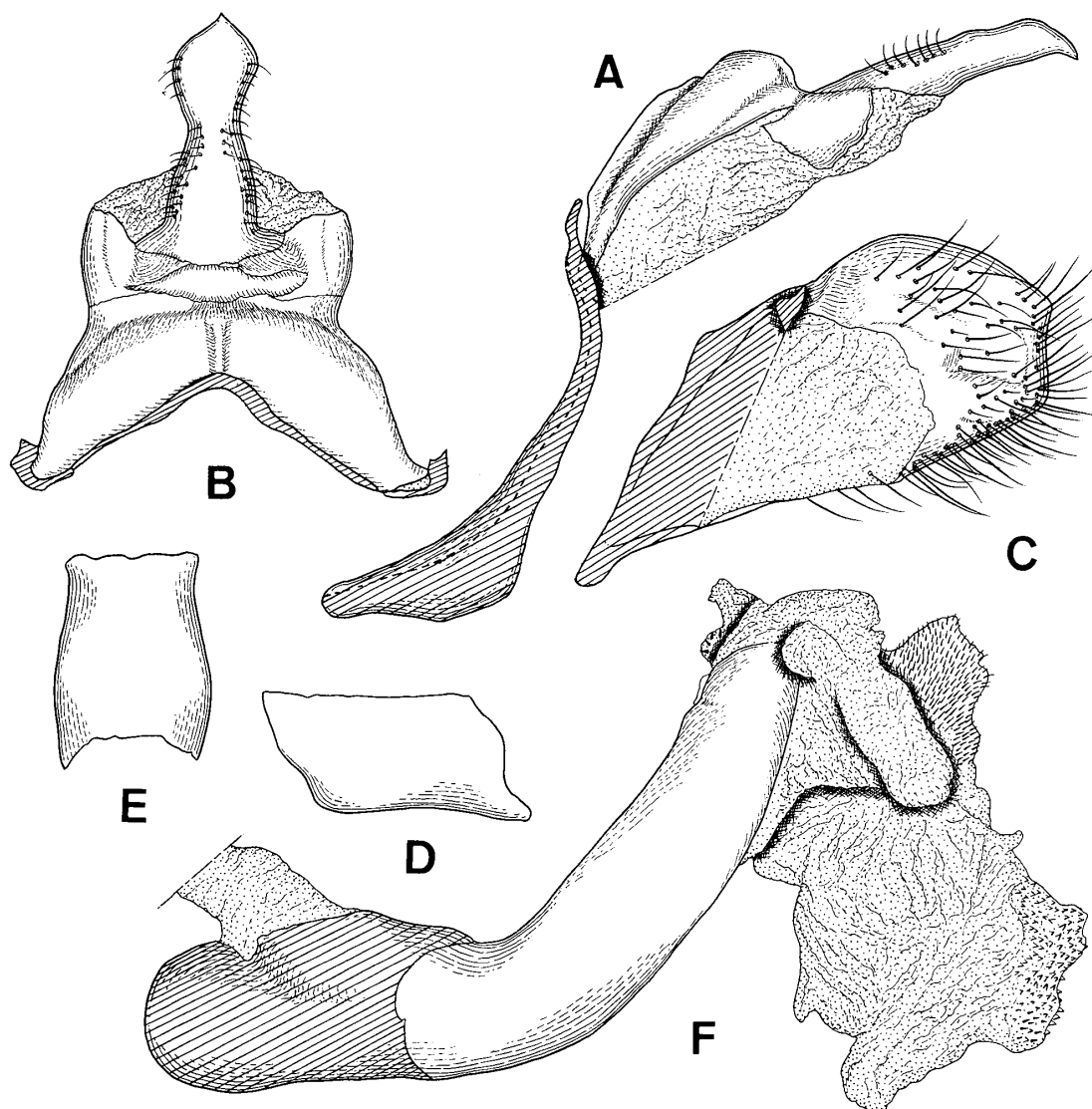


Fig. 46. Male external genitalia of *Rhyarioides subvarius* (WALKER). A. Ring in lateral view; B. Dorsum in dorsal view; C. Inside of right valva; D. Juxta in lateral view; E. *Ditto* in ventral view; F. Phallus in lateral view.

developed. Valva rather small, nearly parallelogrammatic in inner view; costa indistinct, seeming to be short, but no distinct border separating harpe+ampulla; harpe+ampulla occupying dorsal 1/2 of inner wall, dorsal 1/2 of harpe+ampulla usually weakly concaved, ventral 1/2 narrow and continuous to sacculus, with sparse hairs, but in *subvarius* harpe+ampulla evenly flattened; anellifer occupying ventral 1/2 or basal 1/2 of inner wall of valva; sacculus long and narrow. Juxta nearly rectangular, with several short denticles laterally on its apical 1/4–1/3, but entirely bare in *subvarius*. Phallus long and relatively thick; suprazonal sheath strongly curved dorsally, with many small serrations on dorsolateral surface of distal 1/3; subzonal sheath 1/3 as long as aedeagus; vesica everted laterally on the right hand of aedeagus, with minute spinules on its apical portion.

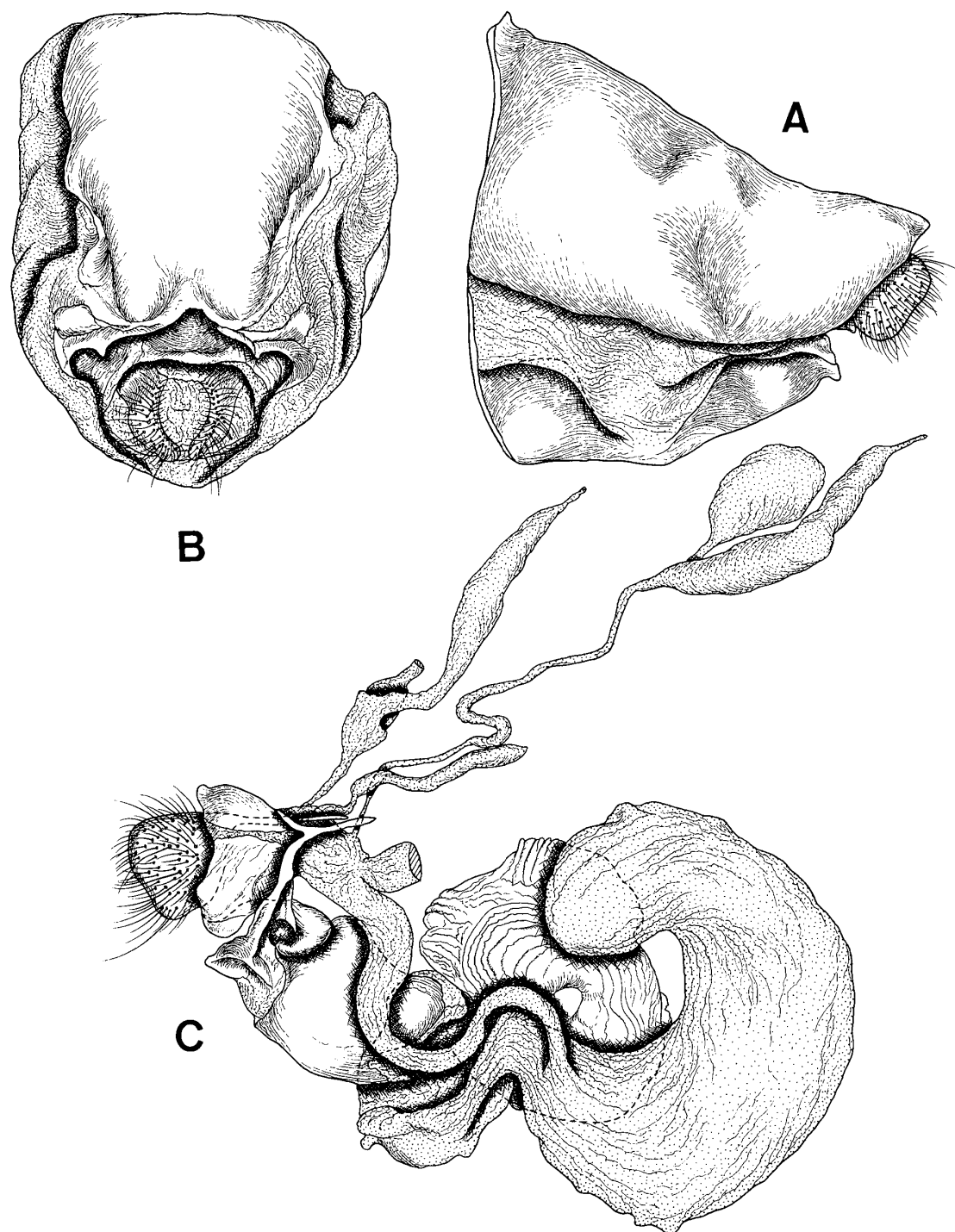


Fig. 47. Female external genitalia and internal reproductive organs of *Rhyparioides amurensis* (BREMER). A. External genitalia in lateral view; B. *Ditto* in posterioventral view; C. Internal reproductive organs in lateral view (right).

Female external genitalia: Seventh abdominal tergum and sternum large; lateral membranous area between them broad; a pair of narrow and complicated sclerites present on posterolateral portions of lateral membranous areas. Eighth abdominal

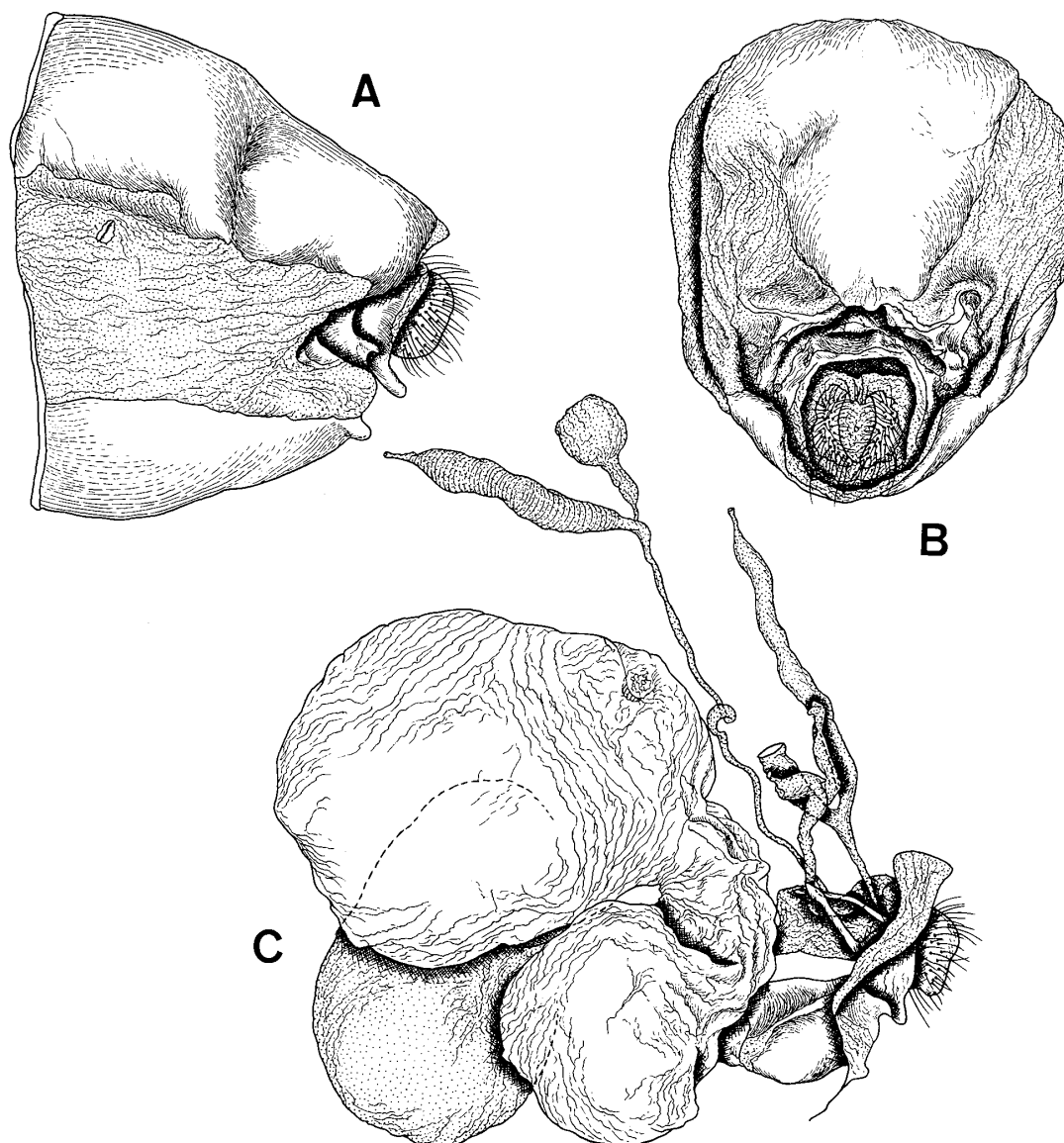


Fig. 48. Female external genitalia and internal reproductive organs of *Rhyarioides nebulosus* BUTLER. A. External genitalia in lateral view; B. *Ditto* in postero-ventral view; C. Internal reproductive organs in lateral view (left).

segment $1/3$ as high as 7th abdominal segment, uniformly sclerotized and its ventral portion produced posteroventrally. Lamella postvaginalis well developed and concaved; a small invagination, which is presumably hooked by uncus tip of the male genitalia during copulation, present on the middle portion. Ostium bursae oval. Apophysis anterioris moderate in length, $2/5 - 1/2$ as long as height of 8th segment. Papilla analis in lateral view rectangular, with many short hairs and several long hairs; apophysis posterioris $1.5\times$ as long as apophysis anterioris.

Female internal reproductive organs: Anterior end of bursa copulatrix reaching to posterior $1/3$ of 6th abdominal segment. Antrum short and rather thick; a narrow membranous slit between antrum and ductus bursae present. Ductus bursae well

sclerotized and thick, $1/4 - 1/3$ as long as bursa copulatrix, attached to posterior $1/3$ of right lateral side of cervix bursae. Cervix bursae weakly sclerotized and globular, connected with corpus bursae by a rather broad duct. Corpus bursae large and slender, situated above cervix bursae, $1/2 - 3/5$ as long as bursa copulatrix; signa which are represented by four circular plates each bearing some small spinules. Lower part of ductus seminalis rather thick, attached to right ventral side of cervix bursae; bulla seminalis very large, situated at the level of right lateral side of corpus bursae; upper part of ductus seminalis arising from near posterior end of right lateral side of bulla seminalis and attached to ventral surface of vestibulum. Spermatheca allantoid. Glandula sevicea rather short, $1/2$ as long as bursa copulatrix. Scent gland rather long and simple.

This genus is well characterized by such apomorphic characters as a serrate carina penis of suprazonal sheath of the aedeagus and the female corpus bursae situated above cervix bursae.

I examined the genitalia of the following species.

1. *Rhyparioides amurensis* (BREMER, 1861) (Figs. 43, 47, 56A, B)
Chelonia amurensis BREMER, 1861, *Bull. Acad. Sci. St. Pet.*, **3**: 477.
 Distribution: Amurland, North and West China, Korea and Japan (Hokkaido, Honshu and Kyushu).
2. *Rhyparioides metelkanus* (LEDERER, 1861) (Figs. 44, 56C, D)
Nemeophila metelkana LEDERER, 1861, *Wien. ent. Monats.*, **5**: 162, pl. 3, fig. 12.
 Distribution: Europe (Northern France and Hungary), East Asia, Amurland, Korea and Japan.
3. *Rhyparioides nebulosus* BUTLER, 1877 (Figs. 45, 48, 56E, F)
Rhyparioides nebulosa BUTLER, 1877, *Ann. Mag. nat. Hist.*, (4) **20**: 396.
 Distribution: Amurland, North China and Japan (Hokkaido, Honshu and Kyushu)
4. *Rhyparioides subvarius* (WALKER, 1855) (Figs. 46, 56G, H)
Diacrisia subvaria WALKER, 1855, List specimen lepid. Insects Colln Br. Mus., **3**: 637.
 Distribution: China, Korea and Japan (Tsushima Is.)

(to be continued)

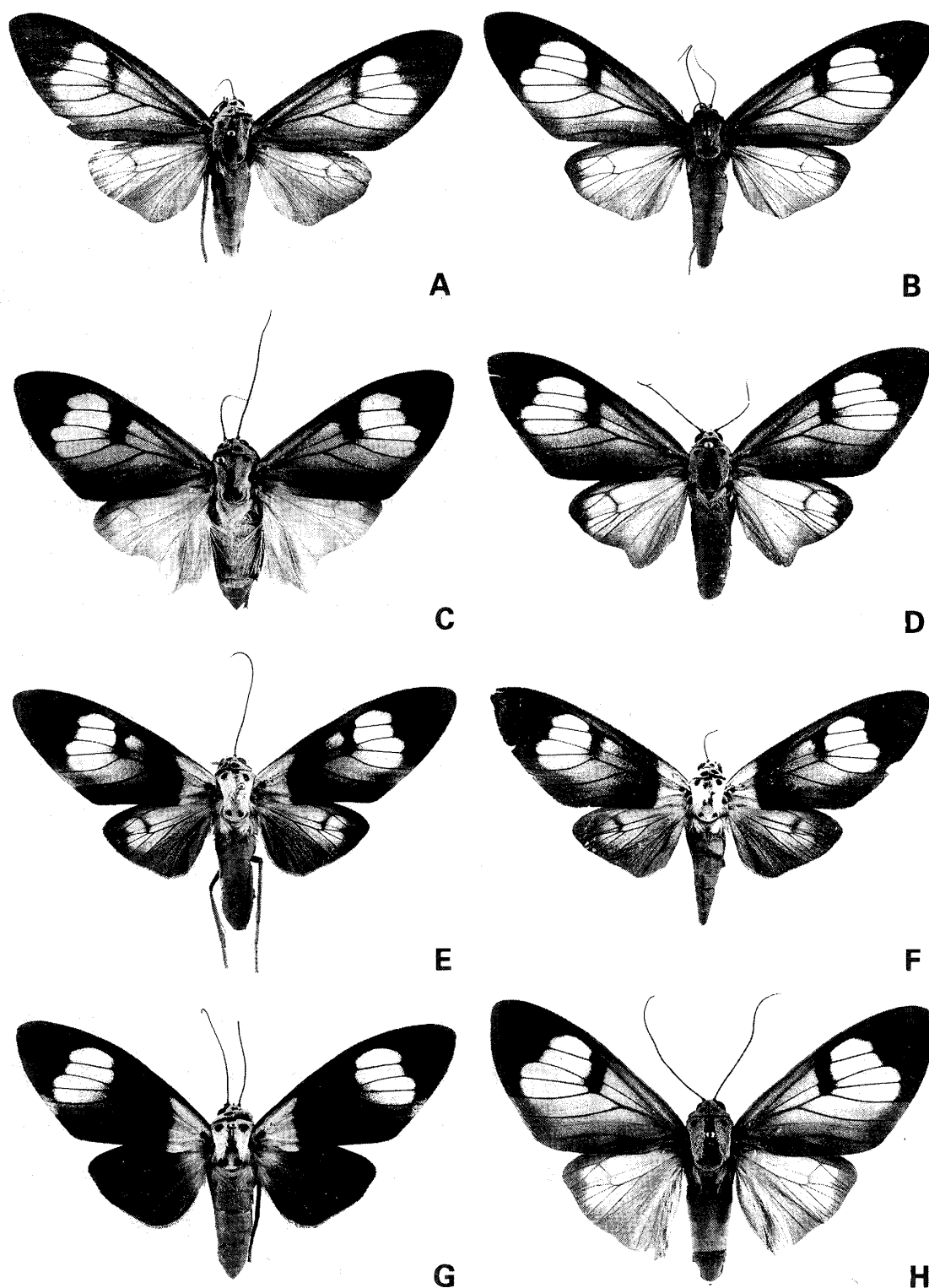


Fig. 49. A. *Amerila astrus* (DRURY), male ; B. *Ditto*, Female ; C. *Amerila caudipennis* (WALKER), male ; D. *Ditto*, female ; E. *Amerila crokeri* (MACLEAY) ; F. *Ditto*, Female ; G. *Amerila nigropunctata* (BETHUNE-BAKER), male ; H. *Amerila arthus-bertrand* (GUER.), male.

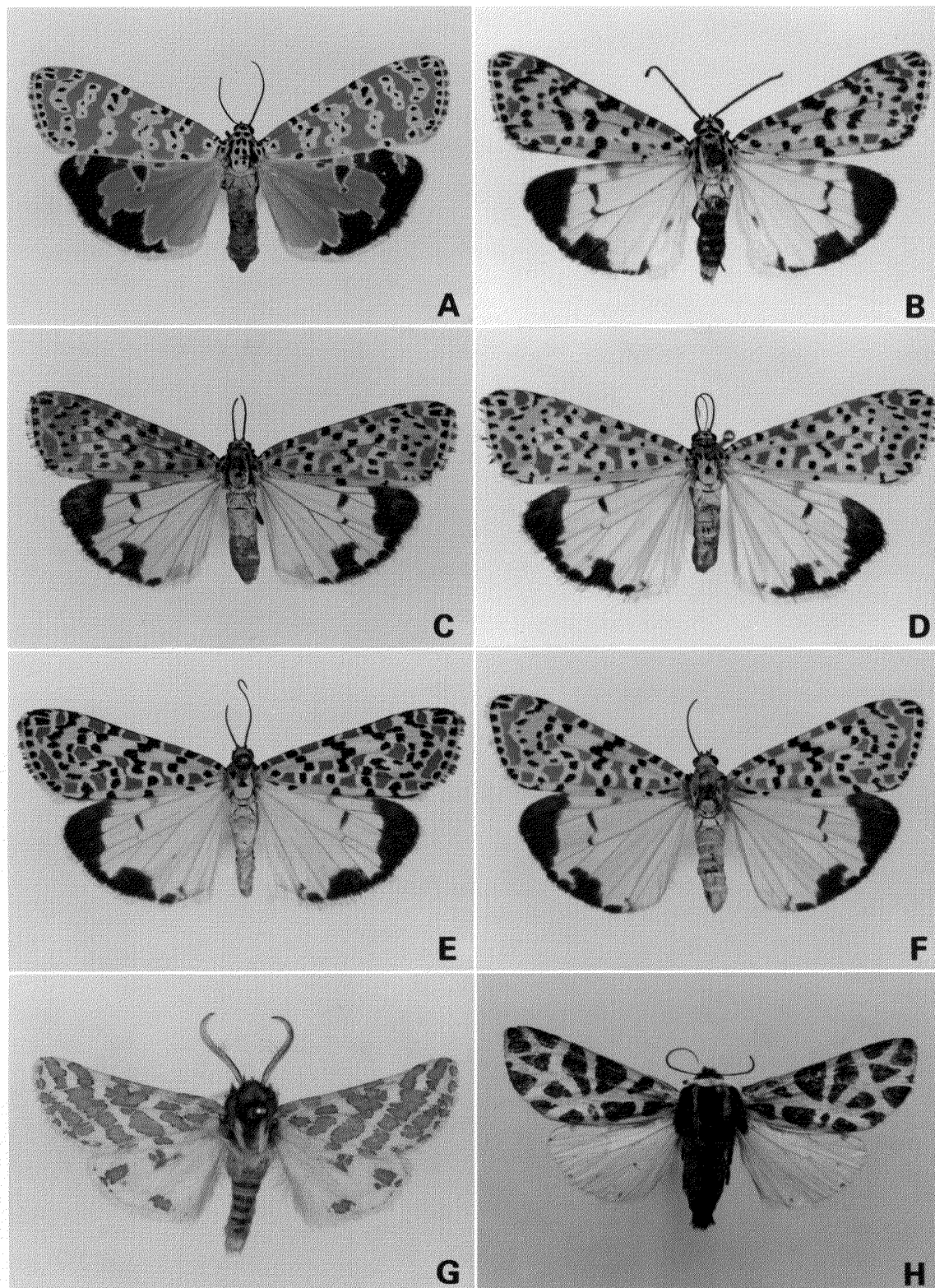


Fig. 50. A. *Utetheisa ornatatrix* (LINNAEUS), male; B. *Utetheisa pulchella* (LINNAEUS), male; C. *Utetheisa lotrix* (CRAMER), male; D. *Ditto*, female; E. *Utetheisa pulchelloides* HAMPSON, male; F. *Ditto*, female.; G. *Lacydes spectabilis* (TAUSHER), male; H. *Cymbalophora pudica* (ESPER), male.

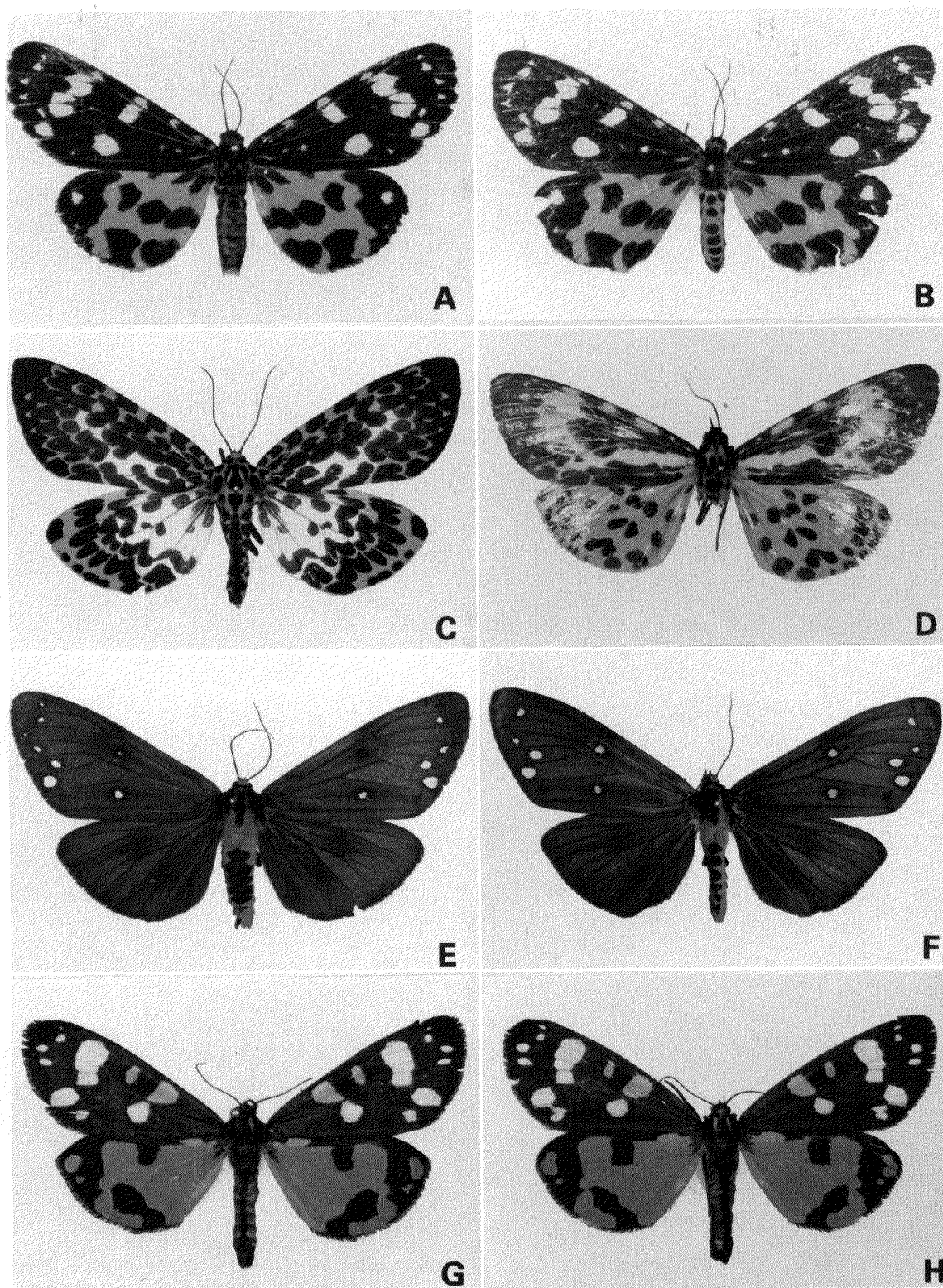


Fig. 51. A. *Nikaea longipennis* (WALKER), Male; B. *Ditto*, Female; C. *Calpenia takamukui* MATSUMURA, male; D. *Calpenia zerenalia* (OBERTHÜR), male; E. *Callimorpha albipuncta* WILEMAN, male; F. *Ditto*, Female; G. *Callimorpha dominula* (LINNAEUS); H. *Ditto*, female.

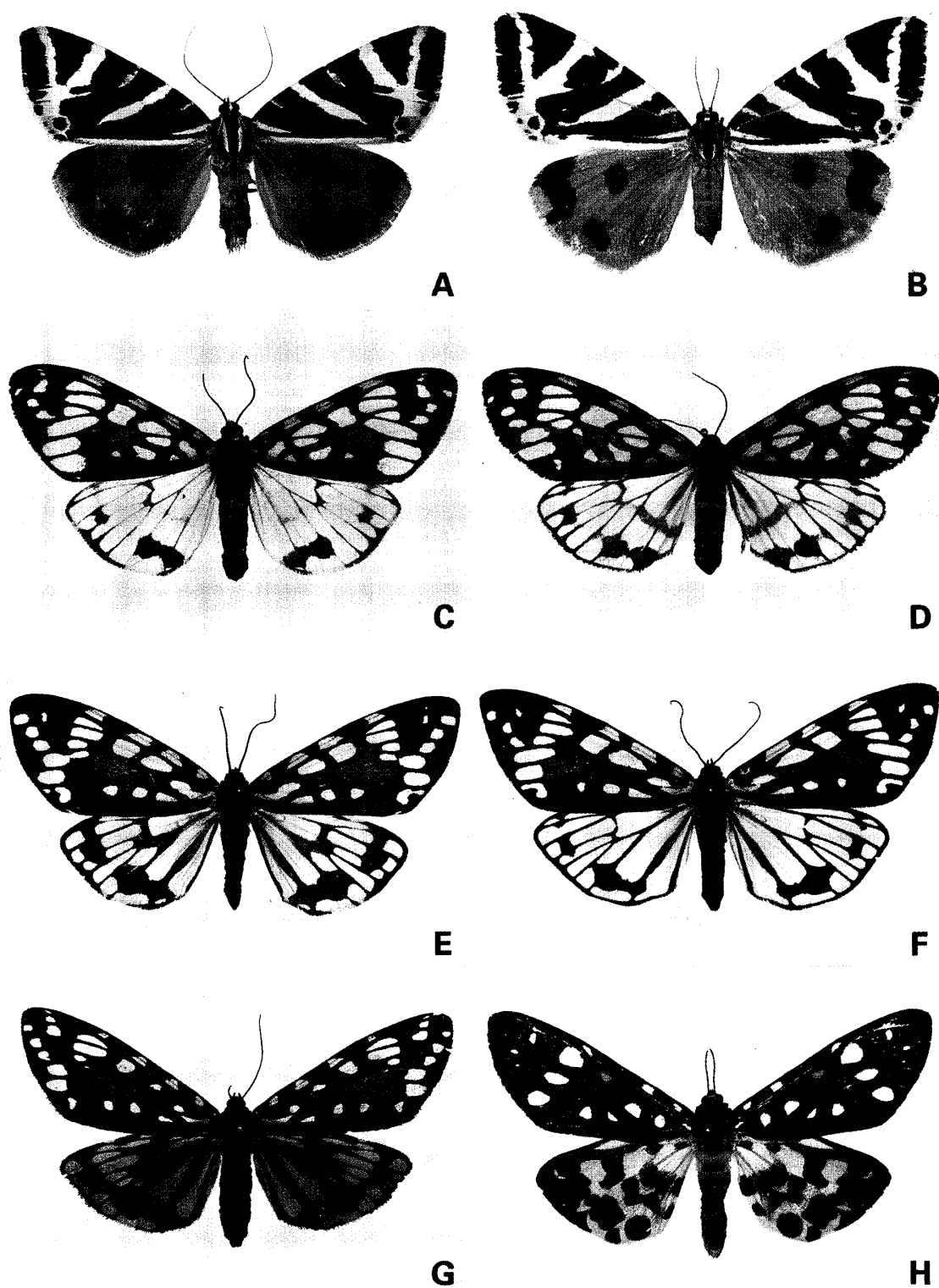


Fig. 52. A. *Callimorpha quadripunctaria* (PODA), male ; B. *Ditto*, female ; C. *Callimorpha similis* (MOORE), male ; D. *Ditto*, female ; E, G. *Callimorpha principalis* (KOL-LER), males ; F. *Ditto*, female ; H. *Aglaomorpha histrio* (WALKER), male.

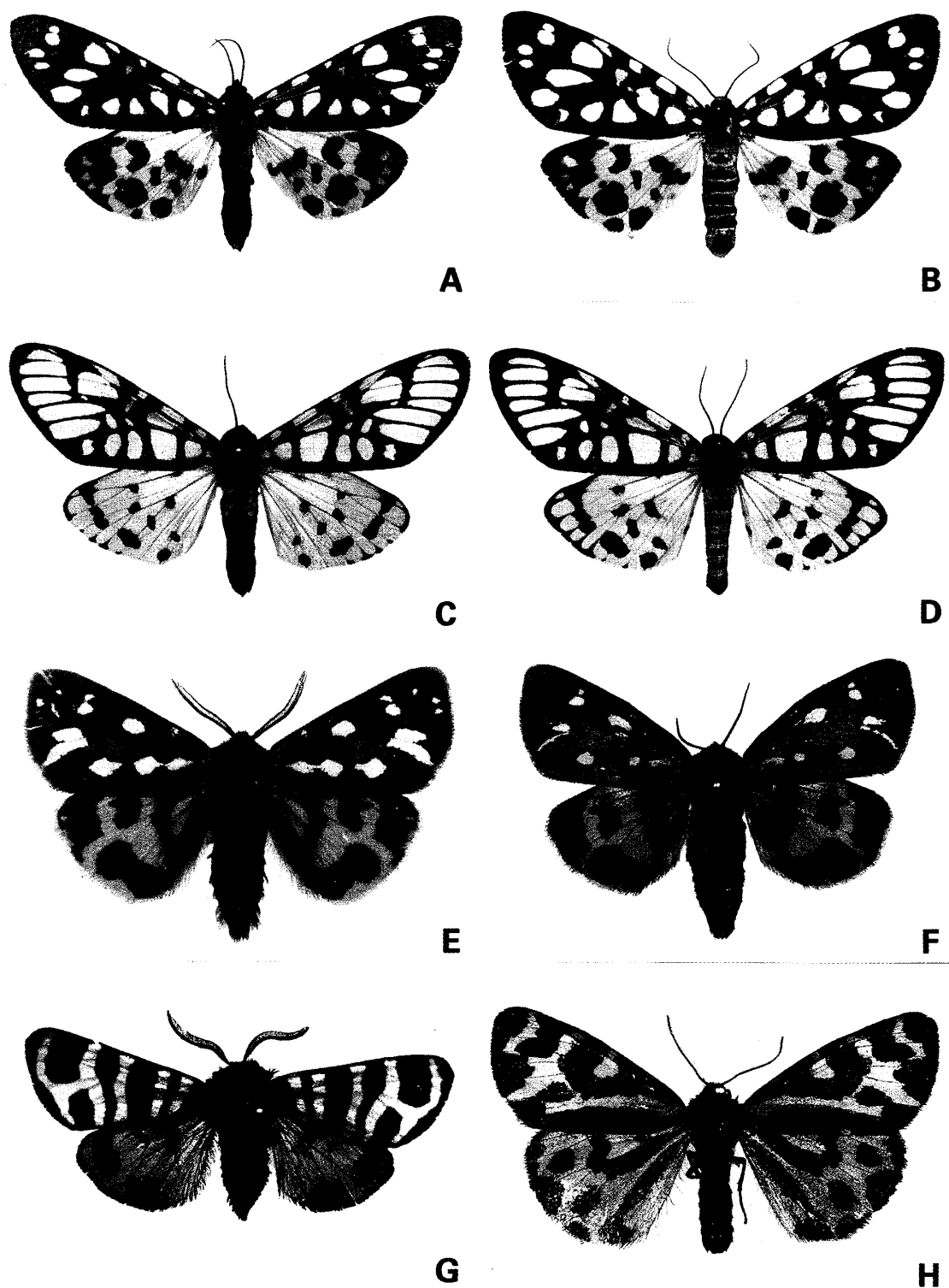


Fig. 53. A. *Aglaomorpha histrio* (WALKER), male; B. *Ditto*, female; C. *Aglaomorpha plagiata* (WALKER), male; D. *Ditto*, female; E. *Hyphoraia aulica* (LINNAEUS), male; F. *Ditto*, female; G. *Eucharis festiva* (HUFNAGEL), male; H. *Parasemia plantaginis* (LINNAEUS), male.

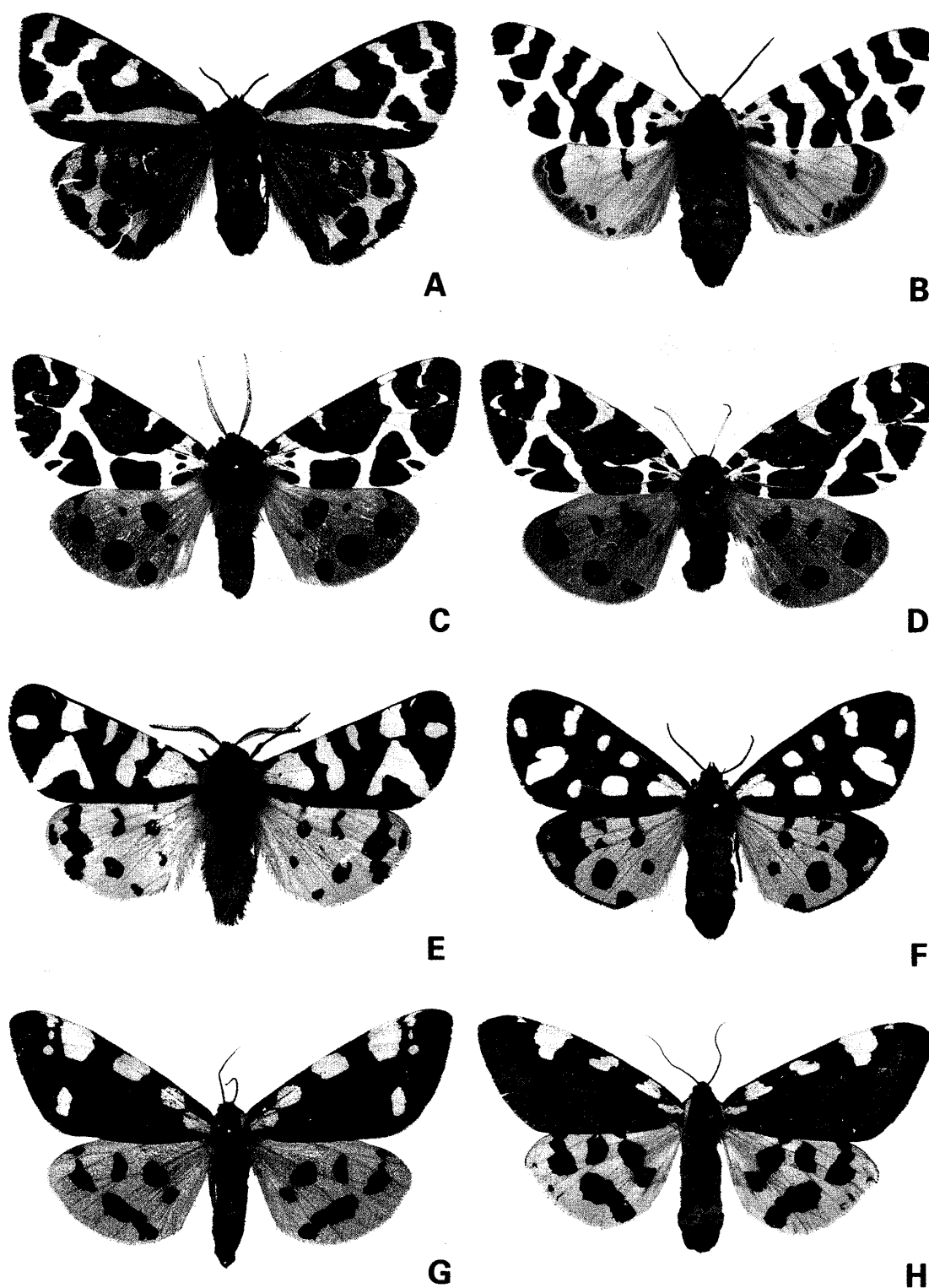


Fig. 54. A. *Parasemia plantaginis* (LINNAEUS), female; B. *Arctia fasciata* (ESPER), female; C. *Arctia caja* (LINNAEUS); D. *Ditto*, female; E. *Epicallia villica* (LINNAEUS), male; F. *Ditto*, female; G. *Pericallia matronula* (LINNAEUS), male; H. *Ditto*, female.

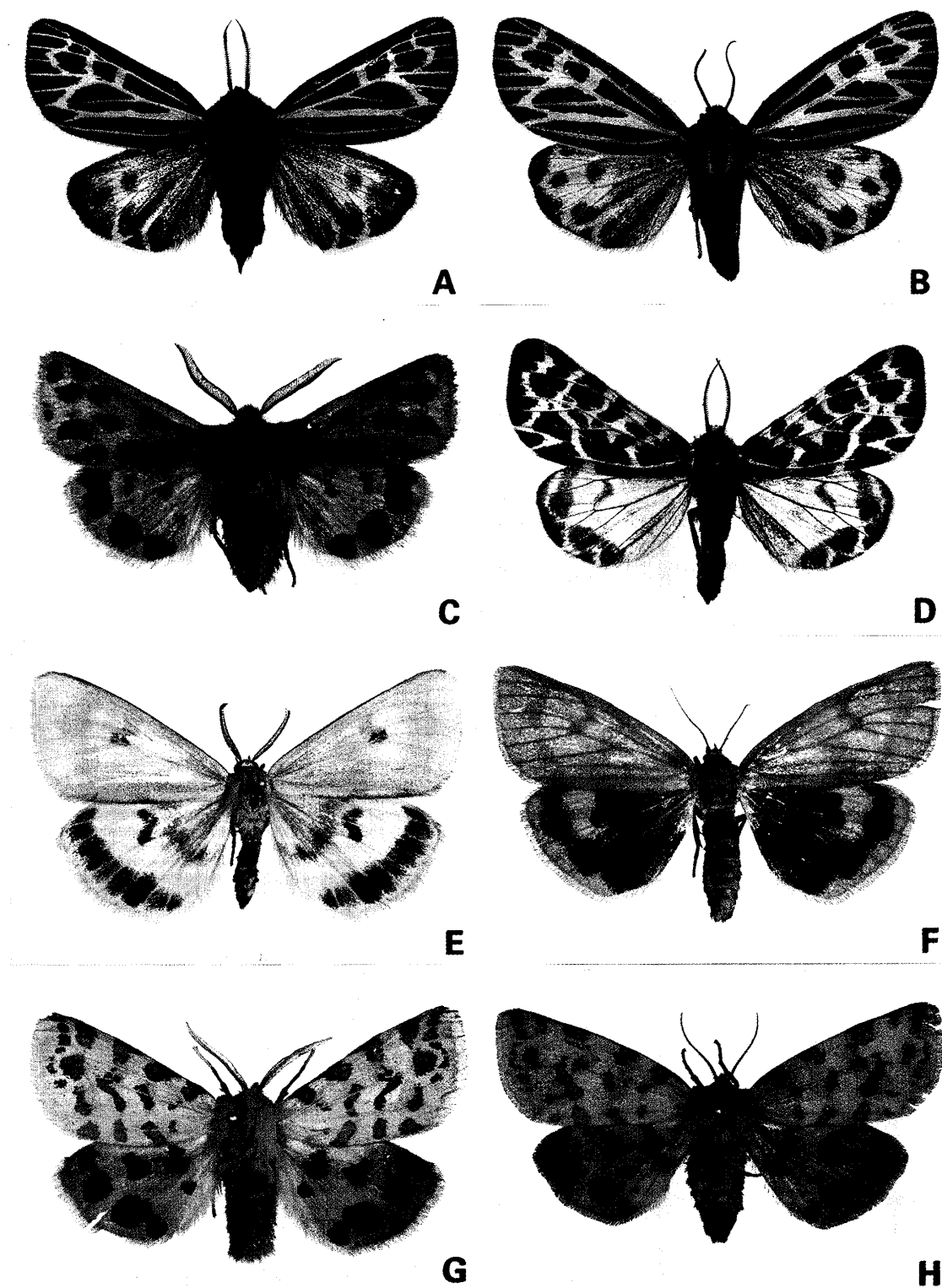


Fig. 55. A. *Grammia quenseli* (PAYKULL), male; B. *Ditto*, female; C. *Chelis maculosa* ([DENIS & SCHIFFERMÜLLER]), male; D. *Hyperborea czekanowskii* GRUM-GRSHIMAILO, male; E. *Diacrisia sannio* (LINNAEUS), male; F. *Ditto*, female; G. *Rhyparia purpurata* (LINNAEUS), male; H. *Ditto*, female.

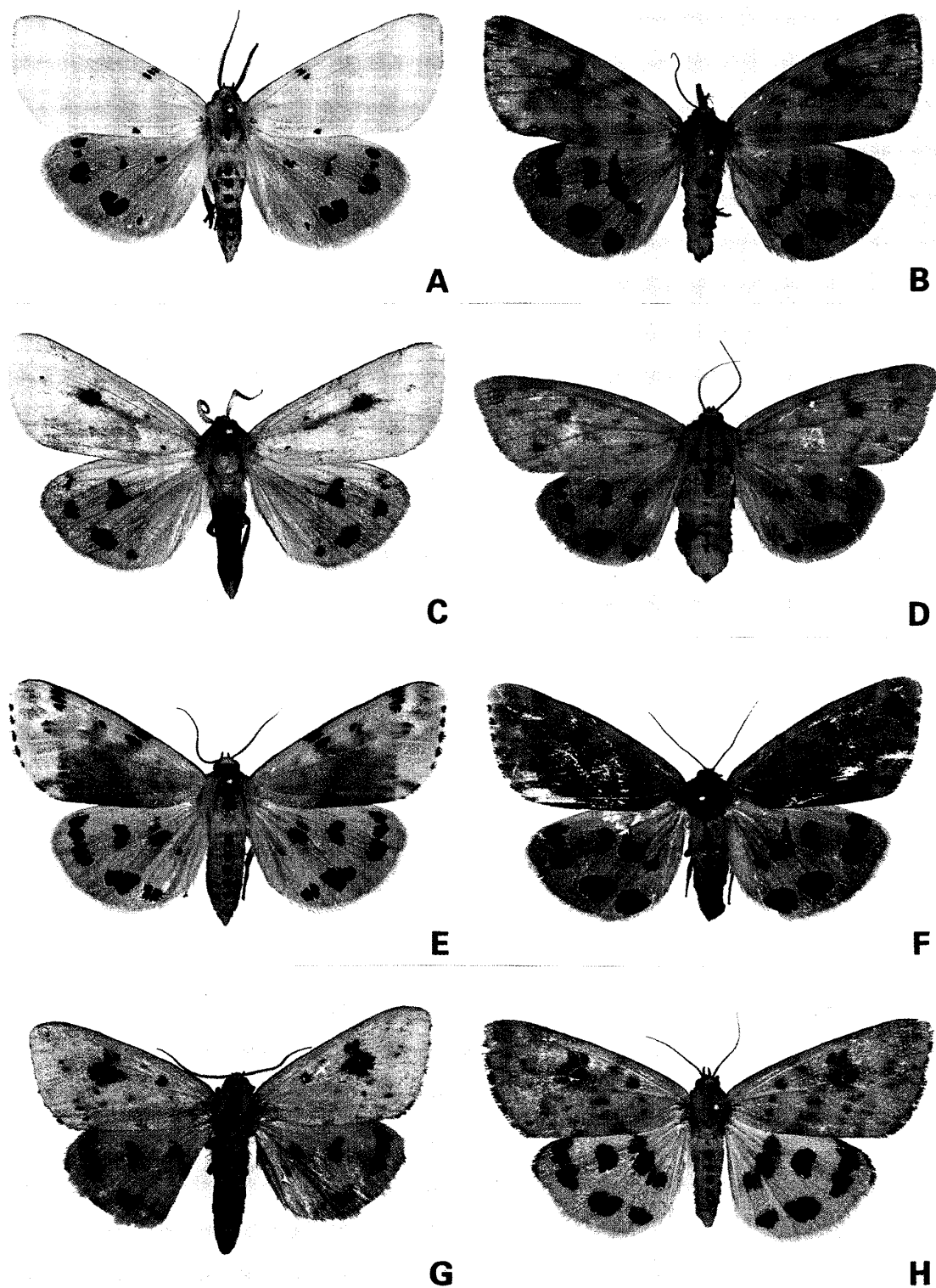


Fig. 56. A. *Rhyparioides amurensis* (BREMER), male; B. *Ditto*, female; C. *Rhyparioides metelkanus* (LEDERER), male; D. *Ditto*, female; E. *Rhyparioides nebulosus* BUTLER, male; F. *Ditto*, female; G. *Rhyparioides subvarius* (WALKER), male; H. *Ditto*, female.